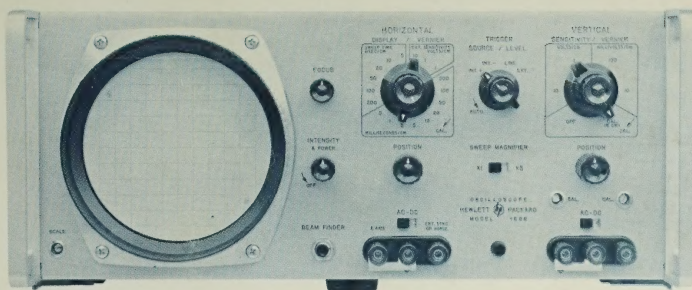



## OPERATING AND SERVICE MANUAL

# OSCILLOSCOPE

## 120B



HEWLETT  PACKARD

## **CERTIFICATION**

*The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.*

## **WARRANTY AND ASSISTANCE**

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.



# MANUAL CHANGES

MODEL 120B

OSCILLOSCOPE

Manual Serials Prefixed: 601—

Manual Printed: NOV 1966

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual:

Serial Prefix or Number      Make Manual Changes

Serial Prefix or Number      Make Manual Changes

|      |      |
|------|------|
| 915— | None |
| 959— | None |
|      |      |
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## ERRATA

Page 5-17, Figure 5-8,

R204: Change value to 1800 ohms, and delete asterisk.

Page 5-18, Figure 5-9,

V308: Change tube type to 6GH8A.

Page 5-19, Figure 5-10,

Add attached Figure 5-9A.

△ R303: Change value to 100 k ohms.

Table 6-2,

A301: Change HP Part No. to 120B-65H.

C8, C15, C102, C304, C306: Change to HP Part No. 0160-2902; same description;  
Mfr 56289; Mfr Part No. 29C214A3CDH. (Preferred replacement.)

C14: Change to HP Part No. 0160-2983; same description, Mfr and Mfr Part No.  
(Preferred Replacement.)

C211, C301, C311: Change to HP Part No. 0160-2897; same description;  
Mfr 05447; Mfr Part No. Type 126. (Preferred replacement.)

C213, C323, C326, C329: Change to HP Part No. 0160-2897; same description;  
Mfr 71590; Mfr Part No. DD203. (Preferred replacement.)

R204: Change to HP Part No. 0758-0043; R: fxd metox 1800 ohms 5% 1/2 W;  
Mfr HP. (Preferred replacement.)

Option 05: Change HP Part No. for lamp holder to 1450-0154.

Option 06:

Change HP Part No. for 3-pin female connector to 1250-0038.

Add: HP Part No. 1251-0039; TQ 2; Connector: 3 contact male; Mfr 71468;  
Mfr Part No. CA3102A10SL-3P-A105.

Change HP Part No. for cable clamp to 1251-0040.

Option 13: Change HP Part No. 120B-5B to 120B-5C.

△ R303: Change to HP Part No. 0693-1041; R: fxd composition 100 k ohms 2 W.  
(Preferred replacement.)

19 February 1970

△ = Latest additions to this change sheet.

This change sheet supersedes all prior change sheets for this manual.

Supplement A for  
120B-903







## OPERATING AND SERVICE MANUAL

# MODEL 120B OSCILLOSCOPE

SERIALS PREFIXED: 601-

(For Instruments With Other Serial Prefixes,  
See Section I and Appendix I)

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1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U. S. A.

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Table 1-1. Specifications

## **SWEEP**

### **Sweep Range:**

One  $\mu\text{sec}/\text{cm}$  to at least 0.5 sec/cm. Fifteen calibrated sweeps accurate to within  $\pm 5\%$ , in a 1, 2, 5, 10... sequence, from 5  $\mu\text{sec}/\text{cm}$  to 200 millisecc/cm. Vernier control permits continuous adjustment of sweep time between calibrated steps, and extends the 200 millisecc/cm to at least 0.5 sec/cm.

### **Sweep Expand:**

X5 sweep expansion may be used on all ranges and expands fastest sweep to 1  $\mu\text{sec}/\text{cm}$ . Expanded sweep accuracy is  $\pm 10\%$ .

### **Automatic Synchronization:**

Internal: from signals 50 cps to 450 kc with approximately 0.5-cm or more vertical deflection; and from line voltage.

External: from signal 50 cps to 450 kc, 1.5 v peak-to-peak.

### **Trigger Point:**

Zero-crossing negative slope of external sync signals; or zero-crossing positive or negative slope of vertical deflection signals. Front-panel control overrides automatic and permits the trigger point to be set between -7 to +7 volts. Turning control fully counterclockwise restores automatic operation.

## **VERTICAL AMPLIFIER**

### **Bandwidth:**

DC coupled: dc to 450 kc. AC coupled: 2 cps to 450 kc. Bandwidth is at least 450 kc regardless of sensitivity setting.

### **Sensitivity:**

10 millivolts/cm to 100 volts/cm. Four calibrated steps with attenuator accuracy of  $\pm 3\%$ , 10 mv/cm, 100 mv/cm, 1 v/cm, and 10 v/cm. Vernier permits continuous adjustment of sensitivity between steps, and extends 10 v/cm step to at least 100 v/cm.

### **Internal Calibrator:**

Calibrating signal automatically connected to vertical amplifier for standardizing of gain, accuracy  $\pm 2\%$ .

### **Input Impedance:**

1 megohm, shunted by approximately 50 pf.

### **Balanced Input:**

On 10 mv/cm range only; input impedance is 2 megohms shunted by approximately 25 pf.

### **Common-Mode Rejection:**

Rejection at least 40 db. Common mode signal must not exceed  $\pm 3$  volts peak.

### **Phase Shift:**

Vertical and horizontal amplifiers have same phase characteristics within  $\pm 2^\circ$  to 100 kc when verniers are in CAL.

## **HORIZONTAL AMPLIFIER**

### **Bandwidth:**

DC coupled: dc to 300 kc. AC coupled: 2 cps to 300 kc. Bandwidth is at least 300 kc regardless of attenuator setting.

### **Sensitivity:**

0.1 volt/cm to 100 volts/cm. Three calibrated steps, accurate within  $\pm 5\%$ , 0.1 v/cm, 1 v/cm, and 10 v/cm. Vernier permits continuous adjustment of sensitivity between steps and extends 10 v/cm step to at least 100 v/cm.

### **Input Impedance:**

1 megohm nominal, shunted by approximately 100 pf.

### **Phase Shift:**

Horizontal and vertical amplifiers have same phase characteristics within  $\pm 2^\circ$  to 100 kc when verniers are in CAL.

## **GENERAL**

### **Cathode Ray Tube:**

P31 phosphor, mono-accelerator with internal graticule normally supplied; 2700-volt accelerating potential. Face plate eliminates glare and reduces hazard of implosion. P2, P7, and P11 phosphors also available.

### **Internal Graticule:**

10 cm x 10 cm marked in cm squares. Major horizontal and vertical axes have 2-mm subdivisions. Eliminates parallax error.

### **Intensity Modulation:**

Terminals on front panel. Plus 20 volt pulse required to blank trace of normal intensity.

### **Dimensions:**

16-3/4 in. wide, 7-1/2 in. high, 18-3/8 in. deep, overall; hardware furnished for quick conversion to 7 in. x 19 in. rack mount.

### **Weight:**

Net: 32 lbs; shipping 45 lbs.

### **Power:**

115 or 230 volts  $\pm 10\%$ , 50 to 1000 cps, approximately 95 watts.

### **Options:**

05. External graticule crt with P31 phosphor.
06. Rear terminals in parallel with front.
10. Provision for single sweep operation.
13. Special front panel for rack mounting only.



## SECTION I GENERAL INFORMATION

## 1-1. INTRODUCTION.

1-2. This manual provides complete instructions on the installation, operation, theory of operation, and maintenance of the Hewlett-Packard Model 120B Oscilloscope.

1-3. The Hewlett-Packard Company uses a two-section, eight-digit serial number (e.g. 000-000000). If the serial prefix (first three digits) on your instrument does not agree with the prefix shown on the title page of this manual, refer to either the separate change sheet included or Appendix I, which contains changes required to adapt this manual to the listed prefixes. The separate change sheet also contains corrections required for all known errata (errors). Contact your Hewlett-Packard Sales/Service Office if additional information or clarification is required.

#### 1-4. DESCRIPTION.

1-5. The Model 120B is a general-purpose oscilloscope whose bandwidth extends from dc to 450 kc. It combines the precision characteristics of calibrated

horizontal sweeps, calibrated vertical sensitivity, and a cert that eliminates parallax error; in addition, its construction provides easy circuit accessibility and quick convertibility from a rack-mounting to a bench-model configuration. Specifications are listed in table 1-1.

1-6. The internal graticule of the Model 120B is in the same plane as the phosphor and crt trace; consequently, crt parallax error is avoided, allowing easier, quicker, and more accurate measurements.

1-7. The Model 120B can be used with either internal or external sweeps, which can be either internally or externally synchronized. Because of its high sensitivity and balanced input, the Model 120B can be used to view complex waveforms and monitor transducer outputs.

1-8. Computations are avoided and possibilities of error are reduced by direct-reading calibrated sweeps. A single control selects 1 of 15 calibrated sweeps between the ranges of 5 microseconds/cm and 200



Figure 1-1. Model 120B Oscilloscope

milliseconds/cm or determines the calibrated sensitivity of the horizontal amplifier. Continuous control of sweep time and horizontal sensitivity between calibrated steps is provided by a vernier control; the vernier control extends the 200 milliseconds/cm sweep time to at least 0.5 seconds/cm, and reduces the horizontal amplifier sensitivity to at least 100 volts/cm.

1-9. Accurate direct-reading sweeps are obtained from a feedback type (Miller) integrator, which ensures high linearity and stability of the horizontal sweep. This type of sweep generator is reliable and relatively independent of vacuum-tube characteristics.

1-10. Observation and analysis of transients are simplified by the expanded-sweep control. This X5 sweep expander may be used on all sweep time settings, and expands the fastest sweep time to 1 microsecond/cm.

1-11. An automatic trigger capability facilitates establishing a base line on the crt when a synchronizing signal is not present. The automatic baseline provision can be easily locked-out and an adjustable trigger level established.

1-12. Accurate voltage measurements of waveforms are quickly made with the Model 120B. A built-in calibrator that is accurate to within  $\pm 2$  percent permits rapid verification and standardization of vertical amplifier sensitivity.

1-13. Phase-shift measurements can be made accurately over a wide range of input frequencies. Relative phase shift between the vertical and horizontal amplifiers is less than 2 degrees up to 100 kc.

#### **1-14. CATHODE RAY TUBE WARRANTY.**

1-15. The cathode ray tube supplied with the Model 120B and replacement crt's purchased from Hewlett-Packard Company are guaranteed against electrical failure for one year from the date of sale by Hewlett-Packard. The Cathode Ray Tube Warranty and Claim sheet is included at the rear of this manual.

#### **1-16. OPTIONS.**

1-17. The Model 120B is available with four options, as listed in table 1-1. Replaceable parts for all options are listed under MISCELLANEOUS at the end of table 6-1.

1-18. OPTION 05. This option provides a crt without internal graticule. An external graticule with adjustable illumination is installed over the face of the crt. Refer to figure 5-9 for a schematic of the added circuit. CRT's without internal graticule are available with types P7, P11, and P31 phosphor. A filter is also supplied with each crt; amber for P7 type, blue for P11 type, and green for P31 type.

1-19. OPTION 06. This option provides rear panel connectors in parallel with the front panel input connectors. One connector is wired in parallel with the VERTICAL input terminals on the front panel, and one connector is wired in parallel with the HORIZONTAL input terminals as shown in figures 5-6 and 5-7. Mating connectors and cable clamps are also supplied. The additional circuitry changes the vertical input capacitance to approximately 75 pf, and the horizontal input capacitance to approximately 135 pf.

1-20. OPTION 10. This option provides circuitry for single sweep operation. Operation procedures are contained in figure 3-2 and a schematic for the added circuit is shown in figure 5-8.

1-21. OPTION 13. This option provides a plain 7 x 9 x 3/16 inch front panel for rack mounting only. The panel is suitable for installing special handles to match existing equipment in system or console configuration.

1-22. AMBER FILTER. A special amber filter is supplied with oscilloscopes having an internal graticule crt with P7 phosphor. This filter may be installed for improved visual observation of displays such as single-shot phenomena or very low frequency applications. The filter will improve the long persistency characteristics desired for visual observations of this type display. To install the filter proceed as follows:

- a. Remove front panel crt bezel.
- b. Set filter into bezel, aligning larger rectangular slots in the edge of filter with metal guide posts of the bezel casting.
- c. Remove oscilloscope top cover for access to rear of crt.
- d. Carefully move crt toward rear of instrument enough to provide clearance for thickness of installed filter (about 1/8 inch).
- e. Loosen clamp at socket of crt.
- f. Replace bezel with filter and tighten bezel screws.
- g. Slide crt forward until light mask on front of crt just lightly touches filter.
- h. Tighten clamp just enough to keep crt from turning. Do not over-tighten the clamp or tube damage may result.
- i. Check alignment of trace with graticule according to the procedure given in Section V of this manual.



## SECTION II INSTALLATION

### 2-1. INCOMING INSPECTION.

2-2. **MECHANICAL INSPECTION.** Unpack and inspect the Model 120B in the presence of the carrier. Be careful when unpacking the instrument, for all electron tubes including the cathode ray tube remain installed during shipment. Save all packing materials until inspection is complete. These materials may be required for reshipment in the event shipping damage is discovered.

2-3. Inspect the instrument for signs of possible damage in shipment such as scratched panel, broken knobs, etc. If possible, energize the equipment and check it operationally (see paragraph 2-5).

2-4. If there are any indications of damage, file a claim with the carrier. Refer to the Hewlett-Packard Warranty sheet at the front of this manual.

2-5. **PERFORMANCE CHECK.** Paragraph 5-52 contains performance check procedures for verifying operation within listed specifications. The performance check is recommended for inclusion in receiving quality-control inspection. The following procedure is offered, however, as a means to check basic operation.

2-6. **INITIAL TURN ON.** Energize the 120B as follows:

- Turn INTENSITY control to OFF and plug in power cable.
- Set SWEEP MAGNIFIER switch to X1 position.
- Set HORIZONTAL DISPLAY switch to 0.5 MIL-SECONDS/CM position.
- Center HORIZONTAL POSITION and VERTICAL POSITION controls.
- Turn 120B on and allow two minutes warmup.
- Set TRIGGER LEVEL to AUTO.
- Rotate INTENSITY clockwise until trace appears. If crt remains blank, press BEAM FINDER and readjust position controls as necessary.
- Adjust FOCUS for thin, well-defined trace, and adjust HORIZONTAL POSITION to place left end of sweep on left-end graticule line.

### 2-7. POWER REQUIREMENTS.

2-8. The Model 120B requires a power source of 115 or 230 volts  $\pm 10\%$ , single phase, 50 to 1000 cps, which can deliver approximately 95 watts. The oscilloscope is normally shipped from the factory wired for use with a 115-volts power source. To convert the instrument for use with a 230-volt source, change the dual primary windings of transformer T302 from a parallel combination to a series combination. Figure 2-1 illustrates the connection for 115- and 230-volt operation. At the time of the change, replace the 1.6-ampere slow-blow line fuse with 0.8-ampere slow-blow fuse.

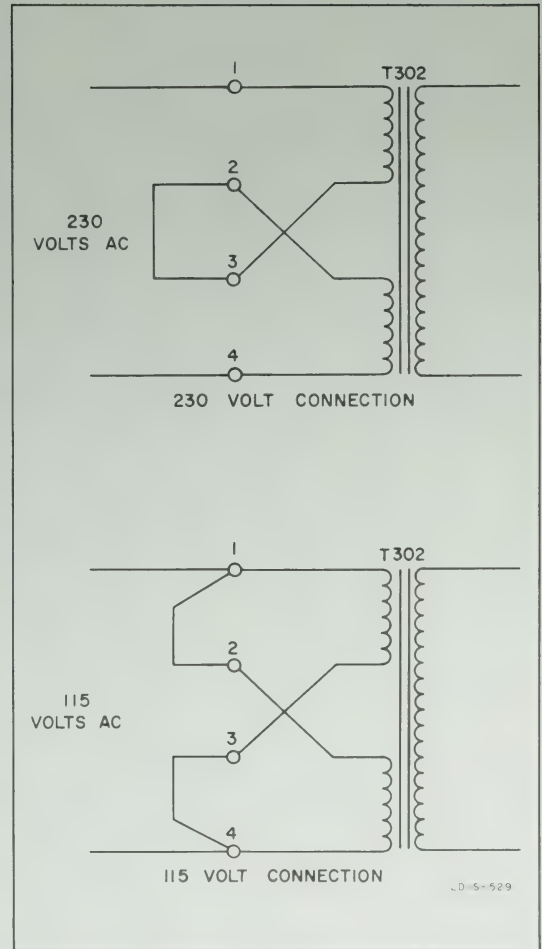


Figure 2-1. Primary-Power Connections

2-9. For the protection of operating personnel, the National Electrical Manufacturers' Assn (NEMA) recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground pin. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.



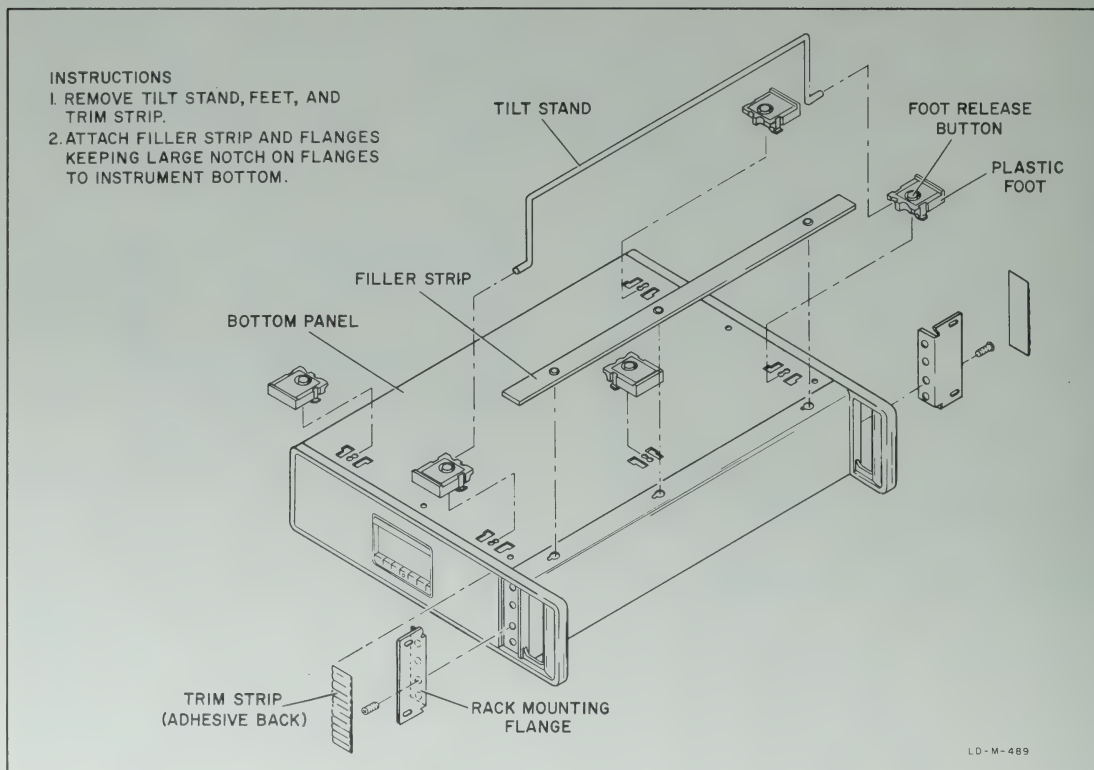


Figure 2-2. Rack Mounting

## 2-10. INSTALLATION.

**2-11. MODULAR CABINET.** The Model 120B Oscilloscope is shipped from the factory as a bench instrument with the tilt stand, feet and plastic trim in place. The top and bottom cabinet covers may be removed, giving complete accessibility to all components and adjustments. When used on the bench, other instruments may be stacked on the louver-free top surface; however, sufficient space should be allowed around the cabinet for adequate circulation of air.

**2-12. RACK MOUNTING.** Prepare the cabinet for rack mounting as illustrated in figure 2-2. The trim strip and rack-mounting flanges are in the shipping container with the instrument. After preparation, lift instrument into place and secure mounting flanges to rack with appropriate screws. Allow adequate ventilation for the instrument in the rack.

## 2-13. REPACKAGING FOR SHIPMENT.

**2-14.** The following list is a general guide for repackaging an instrument for shipment; however, if you have any questions, contact your authorized Hewlett-Packard sales representative.

- If possible, use original container designed for the instrument.
- Wrap instrument in heavy paper or plastic before placing it in shipping container.
- Use sufficient quantities of packing material around all sides of the instrument and protect panel with cardboard strips.
- Use heavy cardboard carton or wooden box to house the instrument and use heavy tape or metal bands to seal the container.
- Mark packing box with "Fragile", "Delicate Instrument", etc.

### Note

If the instrument is to be shipped to Hewlett-Packard Company for service or repair, attach to the instrument a tag identifying the owner, the instrument's complete serial number, and the service or repair to be accomplished; in addition, notify Hewlett-Packard Company or a representative before shipping the instrument. In any correspondence, reference the instrument by model number and complete serial number.

## SECTION III OPERATION

### 3-1. INTRODUCTION.

3-2. This section contains operating instructions for the Model 120B Oscilloscope. Included are descriptions of the Model 120B controls and indicators, and operation of the Model 120B as a general-purpose oscilloscope.

### 3-3. CONTROLS AND INDICATORS.

3-4. Figure 3-1 illustrates the controls and indicators along with a short description of the particular function of each.

### 3-5. GENERAL OPERATING SUGGESTIONS.

3-6. The following paragraphs, 3-7 through 3-16, provide suggestions for expediting and simplifying operation of the Model 120B.

3-7. **SYNCHRONIZING THE SWEEP.** The horizontal sweep can be synchronized with the vertical input signal (INT positions of TRIGGER SOURCE switch), the ac line frequency (LINE position), or an external sync signal (EXT position).

3-8. When the TRIGGER LEVEL control is in AUTO position, a sweep appears on the crt without application of any type of synchronizing signal; however, when a synchronizing signal above approximately 50 cps is applied, the sweep automatically synchronizes with this signal and the sweep is triggered at the point where the signal crosses the zero axis (average dc level of synchronization signal). If a synchronizing signal below approximately 50 cps is being used, the TRIGGER LEVEL control should be out of AUTO position.

3-9. Rotating the TRIGGER LEVEL control in a clockwise direction permits the trigger point to be set between  $\pm 2$  cm along the positive or negative-going portion of a vertical input signal, depending on whether the TRIGGER SOURCE switch is in INT+ or INT- position, respectively. When the TRIGGER SOURCE switch is in EXT position, rotating the TRIGGER LEVEL control in a clockwise direction permits the trigger point to be set between  $\pm 7$  volts along the negative-going portion of the synchronizing signal.

3-10. The particular type of synchronization best suited depends on the type of measurement being made and the type of crt display desired.

3-11. **AC/DC COUPLING.** Ac coupling (AC-DC switch in AC position) removes any dc level present in the vertical or horizontal input signals. This prevents excessive dc levels from deflecting the crt trace off the face of the crt, often to the point where the POSITION controls cannot bring the crt trace within view.

### CAUTION

When using ac coupling, do not exceed a dc level input of 600 volts.

3-12. When pulse or square waves having a frequency less than 200 cps are being measured, dc coupling is recommended (AC-DC switch in DC position).

3-13. **BEAM FINDER OPERATION.** The crt trace may frequently be deflected off the crt face by excessive dc input levels or by misadjustment of the vertical POSITION and horizontal POSITION controls. The BEAM FINDER pushbutton is extremely useful under these conditions. When the BEAM FINDER is depressed, the beam is confined to the face of the crt, brightened, and defocused to prevent burning of the crt phosphor. If the crt trace is centered with the POSITION controls when the BEAM FINDER is depressed, the trace will remain on the crt face when the BEAM FINDER is released.

3-14. **VERTICAL SENSITIVITY SELECTION.** When the vertical VERNIER control is in CAL position, the VERTICAL SENSITIVITY switch provides attenuation of the vertical input signal in four calibrated steps, 10 mv/cm, 100 mv/cm, 1 v/cm, and 10 v/cm. Rotating the vertical VERNIER control in a counter-clockwise direction permits continuous adjustment of sensitivity between steps, and extends 10 v/cm step to at least 100 v/cm. When the VERTICAL SENSITIVITY switch is in CAL position, a calibrating signal is automatically connected to the vertical amplifier.

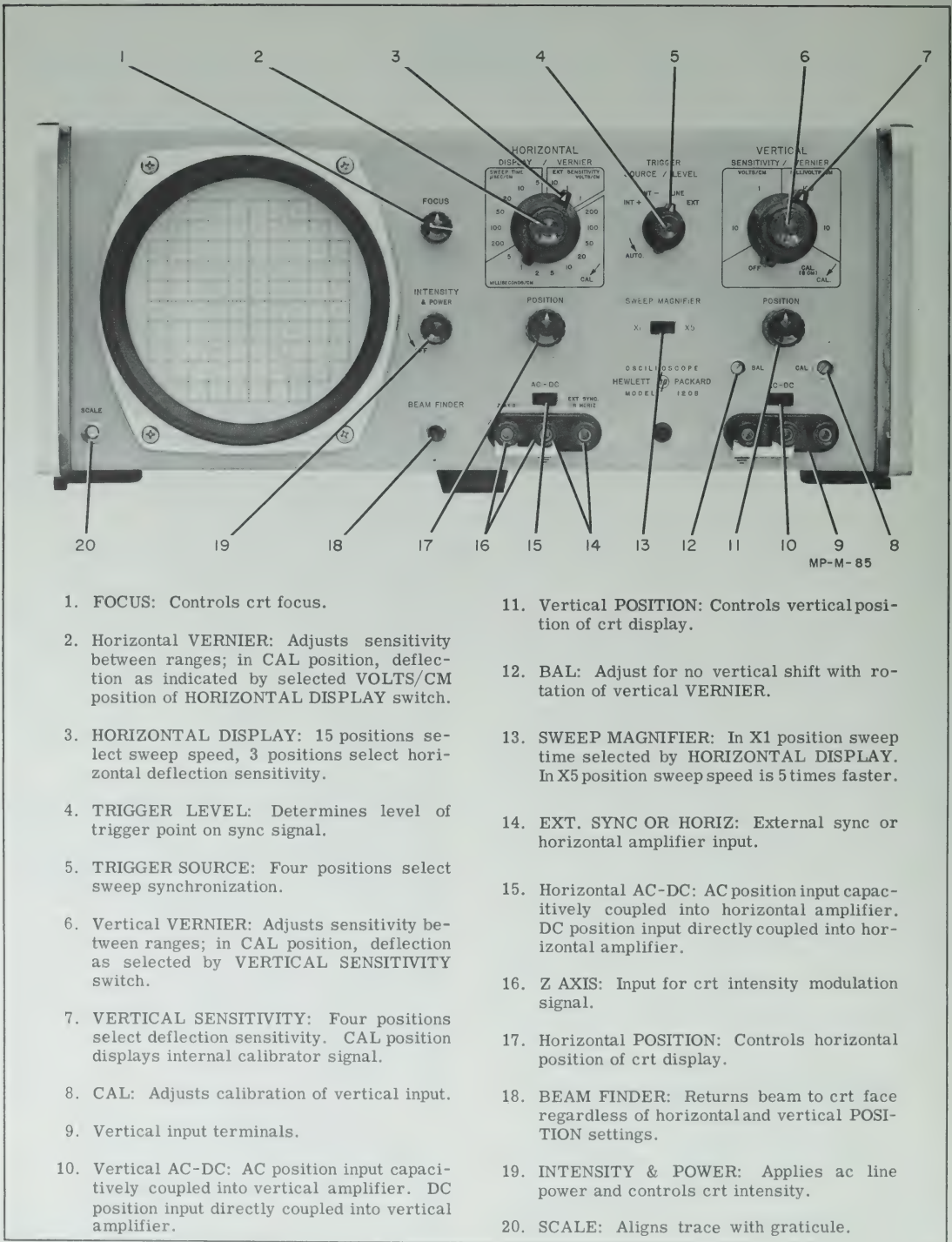
3-15. **COMMON-MODE REJECTION.** Balanced input to the vertical amplifier is obtained by removing the ground jumper across two of the vertical input terminals and applying a balanced signal input. Balanced input is useful in applications where it is desired to simultaneously amplify the out-of-phase (differential) signal and attenuate the in-phase (common mode) signals, such as hum, noise, etc.

3-16. A change in the relative position of the Model 120B Oscilloscope with respect to the earth's magnetic field could result in the trace becoming misaligned. To re-align the trace with the graticule, adjust SCALE, screwdriver adjustment, on the front panel (Figure 3-1).

### Notes

Figures 3-2 through 3-5 assume that the FOCUS, POSITION, and INTENSITY controls are preset by the operator for the desired display.

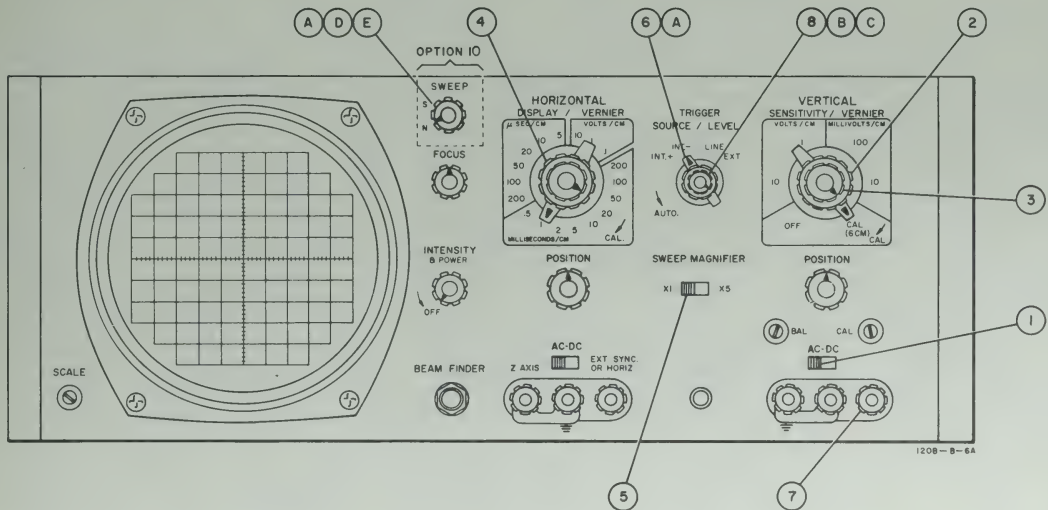
If in doubt as to the exact function of a switch listed in figures 3-2 through 3-5, refer to figure 3-1 for a functional description.



1. FOCUS: Controls crt focus.
2. Horizontal VERNIER: Adjusts sensitivity between ranges; in CAL position, deflection as indicated by selected VOLTS/CM position of HORIZONTAL DISPLAY switch.
3. HORIZONTAL DISPLAY: 15 positions select sweep speed, 3 positions select horizontal deflection sensitivity.
4. TRIGGER LEVEL: Determines level of trigger point on sync signal.
5. TRIGGER SOURCE: Four positions select sweep synchronization.
6. Vertical VERNIER: Adjusts sensitivity between ranges; in CAL position, deflection as selected by VERTICAL SENSITIVITY switch.
7. VERTICAL SENSITIVITY: Four positions select deflection sensitivity. CAL position displays internal calibrator signal.
8. CAL: Adjusts calibration of vertical input.
9. Vertical input terminals.
10. Vertical AC-DC: AC position input capacitively coupled into vertical amplifier. DC position input directly coupled into vertical amplifier.
11. Vertical POSITION: Controls vertical position of crt display.
12. BAL: Adjust for no vertical shift with rotation of vertical VERNIER.
13. SWEEP MAGNIFIER: In X1 position sweep time selected by HORIZONTAL DISPLAY. In X5 position sweep speed is 5 times faster.
14. EXT. SYNC OR HORIZ: External sync or horizontal amplifier input.
15. Horizontal AC-DC: AC position input capacitively coupled into horizontal amplifier. DC position input directly coupled into horizontal amplifier.
16. Z AXIS: Input for crt intensity modulation signal.
17. Horizontal POSITION: Controls horizontal position of crt display.
18. BEAM FINDER: Returns beam to crt face regardless of horizontal and vertical POSITION settings.
19. INTENSITY & POWER: Applies ac line power and controls crt intensity.
20. SCALE: Aligns trace with graticule.

Figure 3-1. Model 120B Oscilloscope, Front View





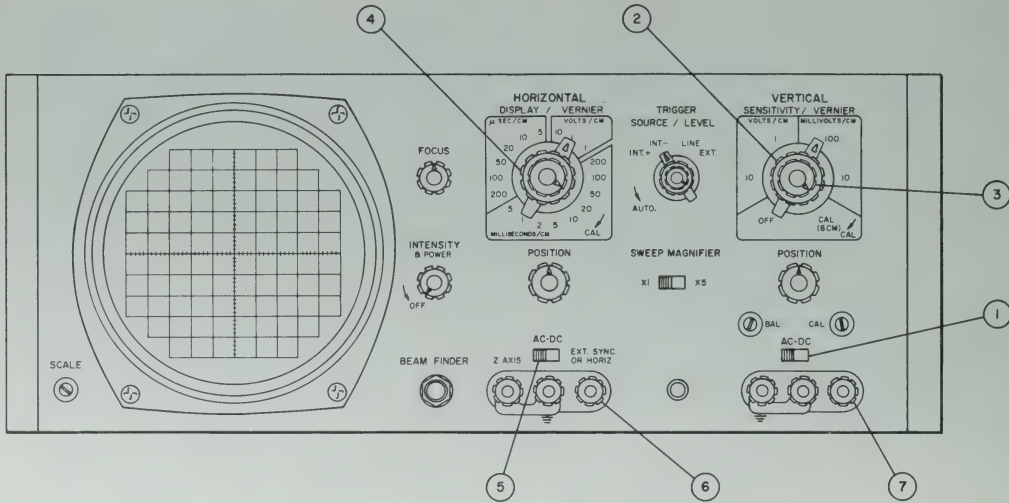
### INTERNAL HORIZONTAL SWEEP:

1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to desired vertical sensitivity.
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired horizontal sweep time. Set VERNIER to CAL for calibrated sweep time.
5. Set SWEEP MAGNIFIER to X1 or X5, as desired.
6. Set TRIGGER SOURCE to desired type of horizontal sweep synchronization. If external sync is selected, connect sync signal to EXT. SYNC.
7. Apply vertical input signal to vertical input terminals.
8. Adjust TRIGGER LEVEL for desired synchronization.

### SINGLE SWEEP (OPTION 10):

- A. Set SWEEP switch to normal (N), TRIGGER SOURCE switch to EXT, and remove any external trigger source.
- B. Adjust TRIGGER LEVEL control fully clockwise. Minimum trigger sensitivity is obtained with the control in this position.
- C. To increase trigger sensitivity, rotate TRIGGER LEVEL control counterclockwise. Maximum sensitivity will be obtained just prior to the point where the oscilloscope sweeps intermittently.
- D. Set SWEEP switch to single (S). The instrument is now in the "armed" state and will sweep once when triggered.
- E. To rearm the sweep circuit, set SWEEP switch from S to N and then back to S. External triggering should not be applied during this operation to prevent the single sweep from occurring immediately when the switch is returned to the S position.

Figure 3-2. Operation Using Internal Horizontal Sweep or Single Sweep



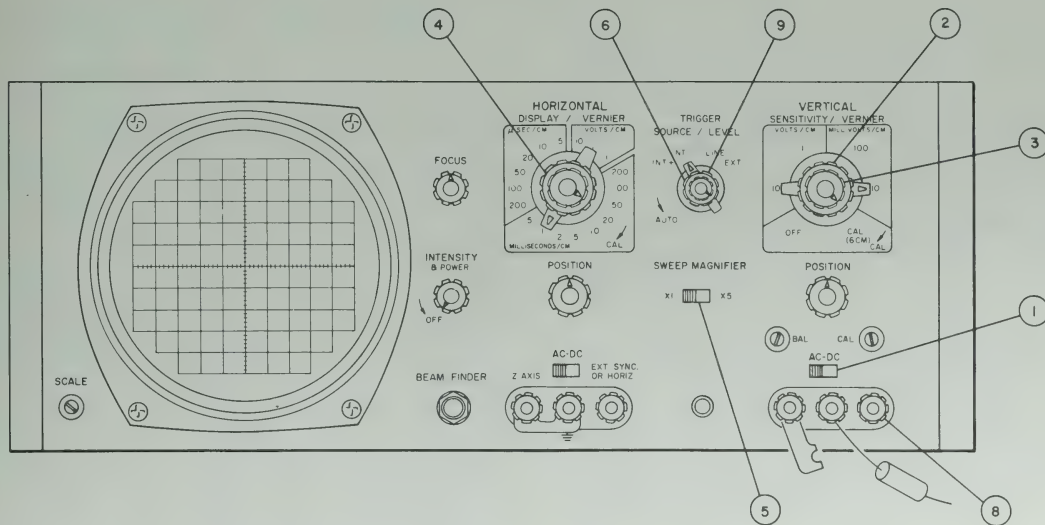
LO-M-491

1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to desired vertical sensitivity.
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired VOLTS/CM. Set VERNIER to CAL for calibrated sensitivity.
5. Set horizontal AC-DC to desired type of coupling.
6. Apply external horizontal sweep to horizontal input terminals.
7. Apply vertical input signal to vertical input terminals.

Note

Relative phase shift of horizontal and vertical amplifiers is the same  $\pm 2^\circ$  to 100 kc only when both VERNIER controls are set to CAL.

Figure 3-3. Operation Using External Horizontal Input



L.O. M-492

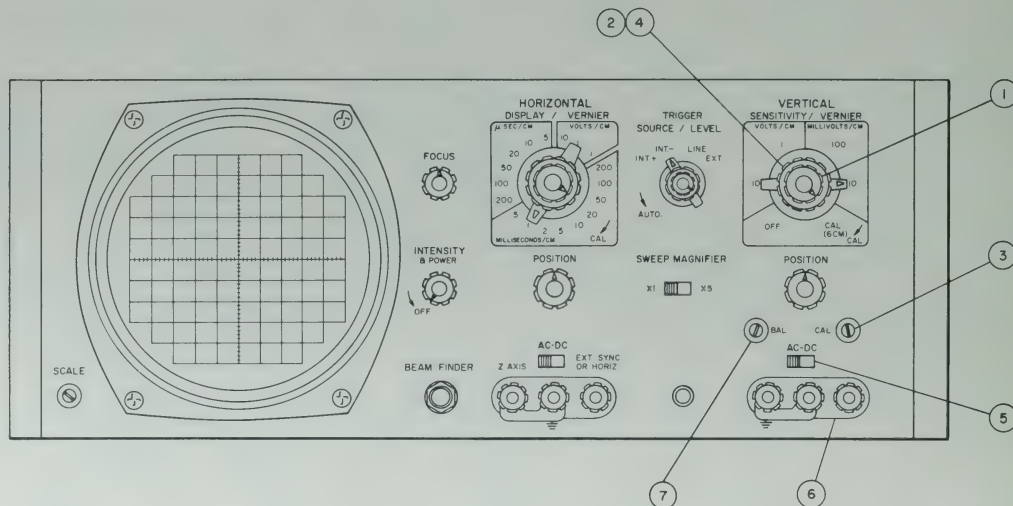
1. Set vertical AC-DC to desired type of input coupling.
2. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM. (Input not balanced in any other position of VERTICAL SENSITIVITY switch.)
3. Set vertical VERNIER to CAL for calibrated sensitivity.
4. Set HORIZONTAL DISPLAY to desired horizontal sweep speed.
5. Set SWEEP MAGNIFIER to X1 or X5, as desired.
6. Set TRIGGER SOURCE to desired type of horizontal sweep synchronization.
7. Remove grounding strap from vertical input terminals.
8. Connect vertical signal to vertical input terminals; if ac coupling is desired, connect 0.1-uf 600-volt capacitor in series with center vertical input terminal.
9. Adjust TRIGGER LEVEL for desired synchronization.

## Note

The common-mode input signal voltage, either positive or negative, must not exceed 3 volts minus the peak amplitude of the differential input signal.

Figure 3-4. Operation Using Balanced Vertical Input





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### CALIBRATION ADJUSTMENTS:

1. Set vertical VERNIER to CAL.
2. Set VERTICAL SENSITIVITY to CAL.
3. Adjust CAL for exactly 6 cm of vertical deflection.

### BALANCE ADJUSTMENTS:

4. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.
5. Set vertical AC-DC to DC.
6. Short vertical input terminals.
7. While rotating vertical VERNIER back and forth, adjust BAL for no shift of spot.

Figure 3-5. Vertical Deflection Calibration and Balance Adjustment

## SECTION IV PRINCIPLES OF OPERATION

### 4-1. OVERALL BLOCK-DIAGRAM DESCRIPTION.

4-2. The oscilloscope is comprised of five major functional circuit groups: the vertical amplifier, the sweep generator, the horizontal amplifier, the low-voltage power supply, and the high-voltage power supply (see figure 4-1).

4-3. The vertical input signal is applied to the vertical amplifier through a frequency-compensated attenuator. The vertical amplifier converts the vertical input to two 180-degree-out-of-phase signals and applies the amplified signals to the crt as the vertical deflection; in addition, the vertical amplifier applies the signals to the TRIGGER SOURCE switch, when they are used as the INT+ and INT- sync signals.

4-4. The horizontal or sync input signal is applied to the HORIZONTAL DISPLAY switch. Depending on the setting of this switch, the signal is applied to either the TRIGGER SOURCE switch (to be used as the external sync signal) or to the horizontal amplifier (to be used as the external horizontal input signal).

4-5. In addition to the internal and external sync signals, the TRIGGER SOURCE switch receives 6.3 volts ac from the low-voltage power supply; this provides for a sync-signal repetition rate equal to the line-voltage frequency.

4-6. The sync signal selected by the TRIGGER SOURCE switch is applied to the sweep generator, wherein the sync signal initiates the horizontal sweep signal and the unblanking gate. The sweep generator applies the sweep signal to the horizontal amplifier, and the resultant amplified sweep is applied to the crt as the horizontal deflection signal. The unblanking gate is applied to the high-voltage power supply. If an external horizontal sweep is being applied in place of the sweep from the sweep generator, the external sweep is amplified by the horizontal amplifier and applied to the crt.

4-7. The low-voltage power supply receives 115/230-volts, single-phase power from the line and generates the following output voltages: 6.3 volts ac, a regulated +19 volts dc, +99 volts dc, +100 volts dc, -150 volts dc, +300 volts dc, and an unregulated +420 volts dc. These voltages are distributed, as required, to the high-voltage power supply, the vertical amplifier, the horizontal amplifier, and the sweep generator.

4-8. The high-voltage power supply generates the high voltages for the crt. The unblanking gate and Z-axis signals applied to the high-voltage power supply effectively alter the value of the power-supply voltages to allow unblanking and modulation of the crt intensity.

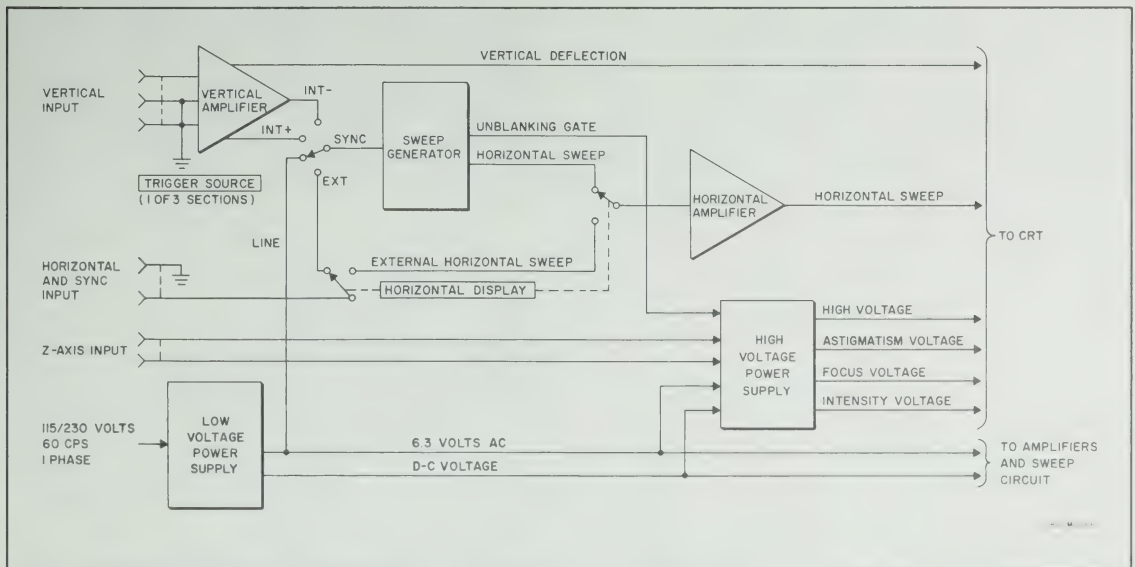


Figure 4-1. Overall Block Diagram

## 4-9. CIRCUIT ANALYSIS.

### 4-10. VERTICAL AMPLIFIER.

4-11. For ac coupling, capacitor C1 is placed in series with the signal path by means of the AC-DC switch. (See figure 5-6.) The input signal is then applied to VERTICAL SENSITIVITY switch S2. When the switch is in the CAL position, the input of the amplifier is directly connected to the output of the calibrator (V4, V5, and associated circuit parts). When the VERTICAL SENSITIVITY switch is in other positions, precision frequency-adjusted attenuators are inserted. These attenuators give a ten-to-one attenuation between adjacent positions. The input signal is then applied to the control grid of amplifier V1A.

4-12. Balanced input to differential amplifier V1B is obtained by removing the ground jumper across resistor R1 (ground strap on front panel) and applying a balanced signal input. Balanced input is useful in applications where it is desired to simultaneously amplify the out-of-phase (differential) signal and attenuate the in-phase (common mode) signals, such as hum, noise, etc. This rejection is an inherent property of differential amplifiers. The common-mode signals are attenuated by 40 db (100:1), whereas any differential input is amplified.

4-13. The vertical amplifier consists of three sets of balanced differential amplifiers (V1, V2, and V3) in cascade. The three stages are neutralized by plate-to-grid cross neutralization. The first stage, V1, has balance and gain adjustments. The balance adjustment (BAL) is potentiometer R16 in the cathode circuit, which adjusts the current distribution be-

tween the two triodes. Potentiometers R21 (VERNIER control) and R20 (CAL) adjust the resistance between the plates and therefore determine the gain of the amplifier. The VERTICAL VERNIER control provides a ten-to-one variation in gain between ranges of the VERTICAL SENSITIVITY switch. The second differential amplifier, V2, has potentiometer R32 (vertical POSITION control) between its cathodes. This potentiometer controls the current distribution between the two triodes and thus determines the vertical position of the crt display. The third differential amplifier, V3, is the output stage. Synchronization signals are taken from the plates of V3 for application to the TRIGGER SOURCE switch. Since the horizontal sweep circuits trigger only on the negative slope of the signal, provision is made to take the proper synchronizing signal from either plate of V3.

4-14. One section of the BEAM FINDER switch is in the cathode circuit of V3. When pressed, the switch increases the common cathode resistance and so reduces the gain of the stage that no amount of unbalance ahead of V3 can deflect the sweep off the crt.

4-15. The calibrator circuit consists of neon lamps V4, V5, and associated circuit parts. When VERTICAL SENSITIVITY switch S2 is placed in the CAL position, V4 ionizes and capacitor C14 begins charging. As the voltage across capacitor C14 rises, the voltage at the junction of V4 and R52 rises proportionally. When the voltage at this junction reaches the firing potential of V5, V5 ionizes. Since the conducting potential of V5 is less the firing potential, the voltage at the junction of V4 and V5 drops, and V4 deionizes. C14 discharges through R53, and the potential across V4 increases. When the potential across

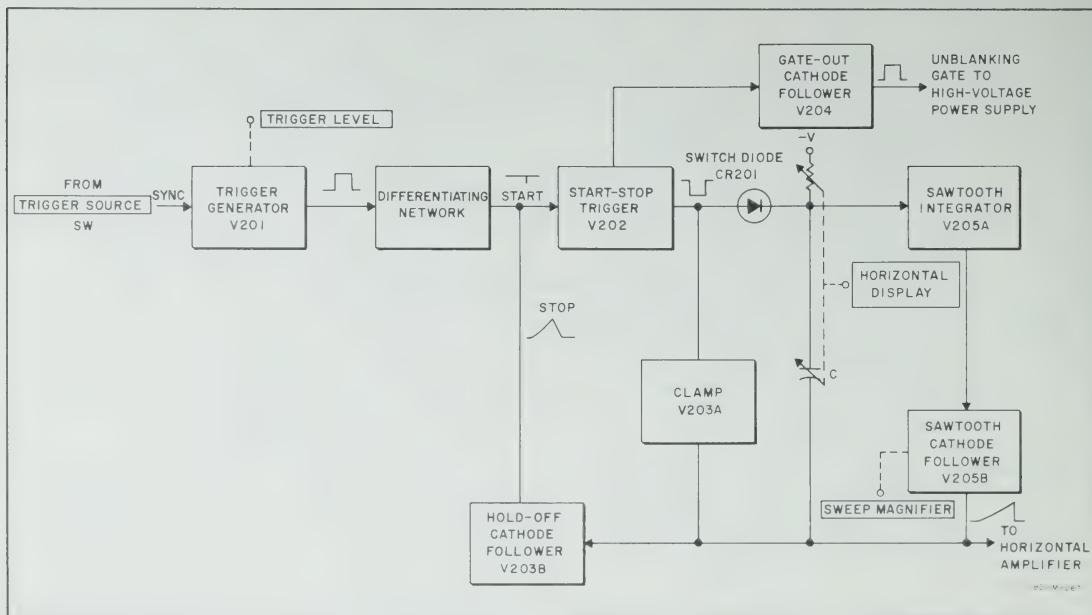


Figure 4-2. Sweep Generator, Block Diagram



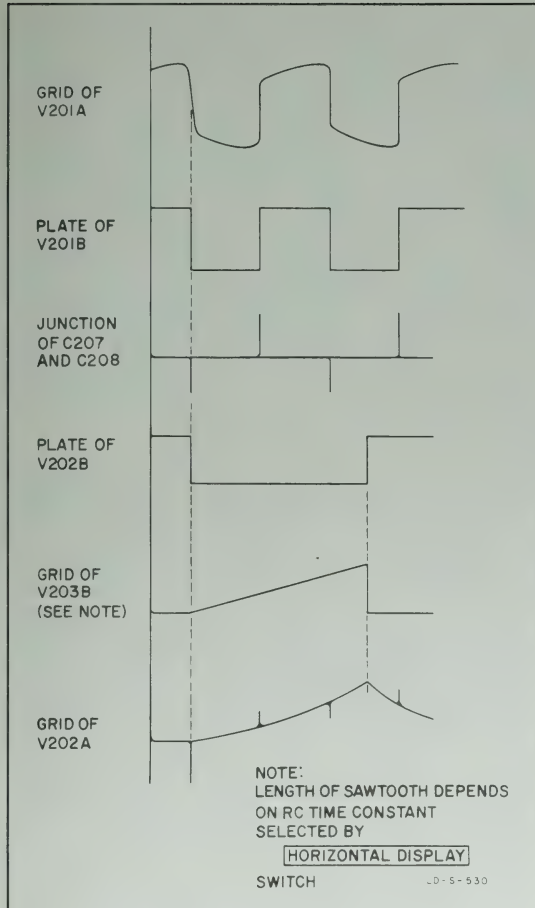


Figure 4-3. Sweep Generator Waveforms

V4 reaches the firing potential, V4 fires and the voltage at the junction of V4 and V5 drops, deionizing V5. C14 starts charging again, and the cycle repeats. A 60-mv square wave is developed across R54, and this signal is applied through the SENSITIVITY switch to the vertical amplifier.

#### 4-16. SWEEP GENERATOR.

4-17. BLOCK-DIAGRAM DESCRIPTION. (See figure 4-2.) The sync signal from the TRIGGER SOURCE switch is applied to trigger generator V201. The trigger generator produces a rectangular wave with a repetition frequency equal to that of the input sync signal. This rectangular wave is applied to a differentiating network which converts it to positive and negative spikes that are coincident with the leading and trailing edges of the rectangular wave. These spikes are then applied to the input of start-stop trigger V202.

4-18. The negative spike switches the start-stop trigger, which produces two step outputs. The positive-going output is applied through V204 to the high-voltage power supply as the crt unblanking gate, and

the negative-going output is applied to switch diode CR201.

4-19. Switch diode CR201 normally clamps the input to sawtooth integrator V205A to a low negative voltage, preventing sawtooth integrator V205A from generating a sawtooth waveform. When the negative-going step signal from the start-stop trigger is applied to the switch diode, however, the diode is reverse biased and allows the sawtooth integrator to generate a sawtooth waveform.

4-20. The sawtooth output of V205B is simultaneously applied to the horizontal amplifier to serve as the horizontal sweep signal and the hold-off cathode follower V203B. The output of the hold-off cathode follower is applied to the input of the start-stop trigger to terminate the sweep. The values of R and C selected by the HORIZONTAL DISPLAY switch determines the slope of the sweep and therefore the time of the sweep. Clamp V204 ensures that the sawtooth always starts at the same level. Figure 4-3 shows the relative timing of the sweep generator waveforms.

4-21. TRIGGER GENERATOR V201. (See figure 5-8.) The sync signal selected by the TRIGGER SOURCE switch is applied through capacitor C202 and resistor R201 to the input control grid of V201, which is a Schmitt trigger circuit when the TRIGGER LEVEL control is not in AUTO. The Schmitt trigger is a form of bi-stable multivibrator, and is used to obtain pulses with rapid rise and fall times.

4-22. Figure 4-4 illustrates a simplified Schmitt trigger and typical input and output waveforms. If initially the input voltage (figure 4-4) is such that V1 is

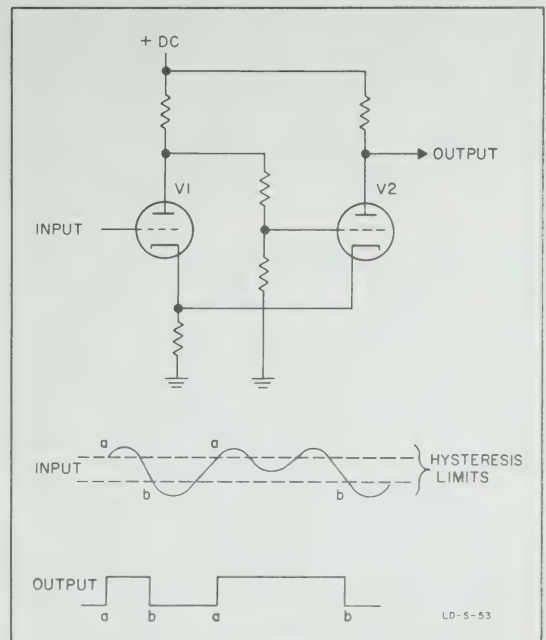


Figure 4-4. Typical Schmitt Trigger

cutoff, V2 conducts. As the input voltage becomes more positive, it eventually reaches a predetermined level (a) at which the circuit changes state; that is, V1 conducts and V2 is cutoff. If the input voltage then goes negative, the common cathode potential decreases and the grid of V2 becomes positive. When the input reaches a second predetermined level (b), V2 conducts and the circuit switches back to its initial state. The output of the circuit is a voltage step, either positive or negative depending upon the slope of the input signal.

4-23. The input voltage levels at which a Schmitt trigger circuit switches are called the hysteresis limits. Note that the circuit (figure 4-4) does not switch unless the input crosses both limits.

4-24. Trigger generator V201 has some additional features: the TRIGGER LEVEL control adjusts the bias on V201A and thus determines the level which the input trigger must reach to change state; in addition, when the TRIGGER LEVEL control is at its extreme limit, switch S202 is placed in AUTO. This opens the shunt across resistor R207 and capacitors C205 and C206, and the trigger generator becomes an astable multivibrator. This provides triggers to the stop-start trigger even though no sync is applied to the trigger generator. When a sync signal above approximately 50 cps is applied, however, the trigger generator then synchronizes with the sync signal. The step output of the trigger generator is taken from the plate of V201B and applied to a differentiating network.

4-25. DIFFERENTIATING NETWORK. (See figure 5-8.) The differentiating network is composed of the series combination of capacitor C207, inductor L201, and resistor R210. The  $r$ - $c$  time constant of this network is extremely small compared with the width of the trigger generator output pulses; consequently, the signal developed across inductor L201 and resistor R210 consists of short negative and positive spikes that are coincident with the leading and trailing edges of the trigger generator output pulses. These spikes are coupled through capacitor C208 to the control grid of V202A, one half of the start-stop trigger.

4-26. START-STOP TRIGGER V202, CLAMP V203A, AND SWITCH DIODE CR201. (See figure 5-8.) The start-stop trigger is a Schmitt trigger circuit. A typical Schmitt trigger is described in paragraph 4-22. V202 is triggered by a negative spike pulse from the differentiating network. One output step waveform is taken from the plate of V202B and simultaneously applies to switch diode CR201 and the grid of clamp V203A. The waveform applied to V203A cuts off V203A, and thus disables the clamping action of this tube. The waveform applied to switch diode CR201 reverse-biases the diode, and thus it ceases conduction. Another step output is taken from the plate of V202A and applied through cathode follower V204 to the high-voltage power supply; this serves as the crt unblanking gate.

4-27. SAWTOOTH GENERATOR V205A AND SAWTOOTH CATHODE FOLLOWER V205B. (See figure

5-8.) Sawtooth generator V205A is a Miller integrator which produces a linear sawtooth waveform. When switch diode CR201 ceases conduction, the integrating capacitor charges through the integrating resistance, producing a negative-going potential at the control-grid of V205A. The amplified signal at the plate of V205A is coupled back through sawtooth cathode follower V205B to the integrating capacitor, completing the negative feedback required by this Miller type integrator.

4-28. The sawtooth signal at the cathode of V205B is also applied to SWEEP MAGNIFIER switch S102. When S102 is in the X5 position, the sawtooth applied to the horizontal amplifier has a peak amplitude five times greater than that applied when S102 is in the X1 position; hence, the angle of slope is increased five times and the sweep time is one-fifth of that selected by the HORIZONTAL DISPLAY switch.

4-29. The sawtooth signal at the cathode of V203B is applied to the control grid of V202A. When the slope of the signal reaches the upper hysteresis limit of the start-stop trigger, the trigger changes state; hence, the unblanking gate output of V203A is terminated. The switch diode CR201 and clamp V204 again conduct, respectively, halting the charging of the integrating capacitor and terminating the sawtooth waveform. The hold-off capacitor in the cathode of V203B charges during the rising slope of the signal output of the hold-off cathode follower but does not immediately discharge when the sawtooth input to the hold-off cathode follower terminates. This prevents the start-stop trigger from again being triggered by a negative spike until the sweep circuits have fully recovered. A different value of hold-off capacity is selected for each setting of the HORIZONTAL DISPLAY switch.

#### 4-30. HORIZONTAL AMPLIFIER.

4-31. The grid of V101A (figure 5-7) receives either the sweep output from the horizontal sweep circuits or from an external sweep source, depending on the setting of the HORIZONTAL DISPLAY switch. When external sweep is being used (EXT SENSITIVITY positions), any one of three horizontal sweep sensitivities can be selected: .1 VOLTS/CM, 1 VOLTS/CM, or 10 VOLTS/CM. The AC-DC switch allows selection of direct coupling, or ac coupling through capacitor C101.

4-32. The horizontal amplifier consists of two differential amplifiers (V101 and V102) in cascade. When the HORIZONTAL DISPLAY switch is set to one of the EXT SENSITIVITY positions, the resistance between the cathodes of amplifier V101 consists of the horizontal VERNIER control (R275B) in series with the horizontal gain control (R104); otherwise, resistor R107 is between the cathodes. The horizontal POSITION control (potentiometer R109) between the plates of V101 controls the horizontal position of the crt trace. The second stage (V102) is neutralized by plate-to-grid cross neutralization. The output of the horizontal amplifier is taken from the plates of V102 and applied directly to the horizontal deflection plates of the crt.

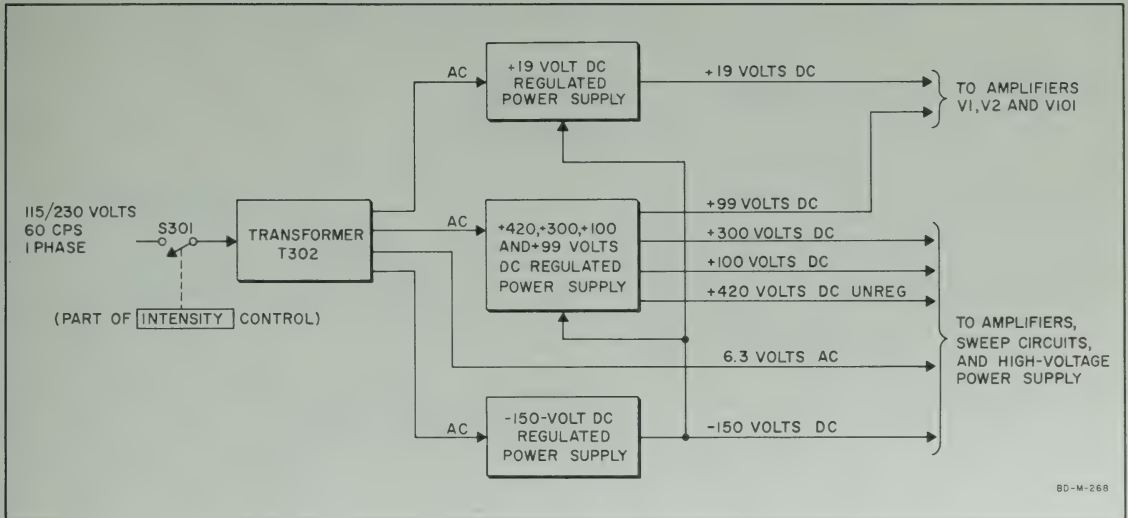


Figure 4-5. Low-Voltage Power Supply, Block Diagram

4-33. One section of the BEAM FINDER switch is in the cathode circuit of V102. When pressed, the switch increases the common cathode resistance and so reduces the gain of the stage that no amount of unbalance ahead of V102 can deflect the sweep off the crt.

#### 4-34. LOW-VOLTAGE POWER SUPPLY.

4-35. BLOCK-DIAGRAM DESCRIPTION. (See figure 4-5.) The 115/230-volt, single-phase power is applied through switch S301 to transformer T302. The transformer applies 6.3 volts ac to the vertical amplifier, horizontal amplifier, sweep generator, and high-voltage power supply for use as filament voltage; the transformer also applies appropriate ac voltages to the following: the +19-volt d-c regulated power supply; the +300-, +100-, and +99-volt dc regulated power supply; and the -150-volt dc regulated power supply.

4-36. The regulated power supplies deliver their dc outputs to the following circuits: +19 volts dc is applied to the horizontal and vertical amplifiers; and +19, +100, +300, and -150 volts dc are applied to the vertical amplifier, the horizontal amplifier, the horizontal sweep circuits, and the high-voltage power supply; in addition, the -150-volt supply applies a negative voltage to the +19-, +99-, +100-, and +300-volt supplies for use as a control voltage.

4-37. -150-VOLT DC REGULATED POWER SUPPLY. The -150-volt supply (figure 5-9) in the 120B is used as a reference supply for the +300-, +100-, and +99-volt supplies; therefore, any change in the -150 volt supply is reflected as a change in these supply voltages. The ac voltage from T302 is rectified and partially filtered by rectifier CR303 and capaci-

tor C325A. The resulting dc voltage is regulated further by tubes V309, V310, and V311.

4-38. The circuit functions as follows: when power is applied (assuming the -150-volt supply has been adjusted properly) the cathode of V310 becomes fixed at -65 volts and the grid assumes a slightly more negative value. If a line voltage surge or load current change were to occur, tending to lower the supply voltage, V310 grid potential would tend to change by half the amount, since the grid is tied to a voltage divider between -150 volts and ground. The result is increased bias for V310, lowering its current, raising its plate voltage, which, in turn, lowers the bias on V309. This bias change in V309 lowers its resistance, decreasing the voltage drop across this element which tends to return the supply voltage to its original value.

4-39. +300-, +100- AND +99-VOLT DC REGULATED POWER SUPPLY. The +300-volt supply (figure 5-9) operates in almost exactly the same manner as the -150-volt supply except that it uses the -150-volt supply as its voltage reference. In this supply, CR301, CR302, V307, and V308 are the rectifier, series regulator, and amplifier, respectively. The +100- and +99-volt supply is further regulated by V308B, referenced to the +300-volt supply.

4-40. +19-VOLT DC REGULATED POWER SUPPLY. (See figure 5-9.) The +19-volt supply (for the filaments of vertical amplifiers V1 and V2) uses rectifier CR304 and capacitor C328 for rectifier and filter. Transistor Q301 is a series regulator using the potential across Zener diode CR302 for its voltage reference. The current in transistor Q301 determines the value of the dc voltage across the filaments.



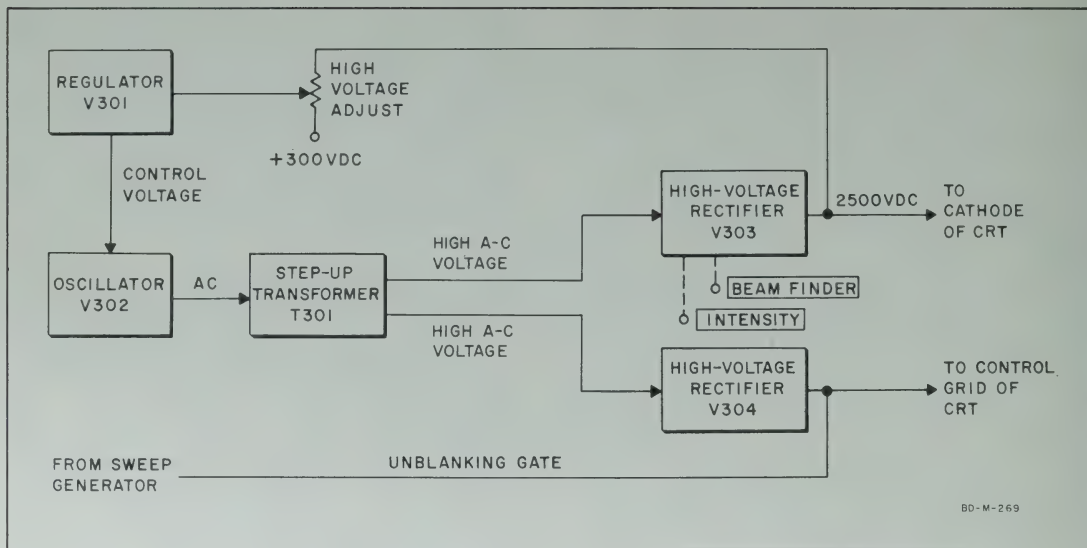


Figure 4-6. High-Voltage Power Supply, Block Diagram

#### 4-41. HIGH-VOLTAGE POWER SUPPLY.

4-42. BLOCK-DIAGRAM DESCRIPTION. (See figure 4-6.) Oscillator V302 generates an ac voltage and applies it to step-up transformer T301. The stepped-up ac voltage is applied to rectifiers V303 and V304. The negative high-voltage output of V303 is applied to the cathode of the crt, and the negative high-voltage output of V304 is applied to the control grid of the crt. The difference between the two voltages is the crt bias and thus controls the crt intensity.

4-43. When the INTENSITY control setting is changed, a change occurs in the cathode high voltage, causing a change in the voltage level at the wiper of the -2500-volt adjust potentiometer. This results in regulator V301 altering the control voltage in a direction necessary to return the cathode high voltage to its original value; however, this now results in the control-grid high voltage being higher or lower than previously and thus the crt intensity is altered.

4-44. HIGH-VOLTAGE RECTIFIER V303. (See figure 5-10.) The ac high voltage present in one secondary winding of T301 is rectified by V303 and filtered by capacitor C308. A portion of the +100 volts dc taken from the wiper of INTENSITY potentiometer R321 is effectively in series with and opposing the high-voltage output of V303. When the BEAM FINDER pushbutton is depressed, the opposing voltage from the wiper of potentiometer R321 is effectively removed and the intensity of the crt trace is increased.

4-45. When a signal is applied to the Z AXIS input, the signal is applied through capacitor C307 to the cathode of the crt and thus modulates the crt intensity.

4-46. A voltage-divider network, consisting of resistors R313, R311, R310, R309, R307, potentiometers R312 (FOCUS control) and R308 (-2500 adjust), is tied between +300 volts dc and the cathode of the crt. The voltage present at the wiper of R312 is applied to the crt focusing grid as focusing voltage, and the voltage present at the wiper of R308 is applied to amplifier V301B as the high-voltage control voltage.

4-47. AMPLIFIER V301. (See figure 5-10.) When a change in the value of the high voltage occurs, a corresponding change occurs at the wiper of potentiometer R308. This alters the bias at the grid of V301B, and the resultant change in the plate voltage is dc coupled through R305 to the control grid of V301A. This, in turn, results in a change in the plate voltage of V301A, which is connected to the screen grid of oscillator V302. The overall effect is that when the high voltage decreases, the screen grid voltage of V302 increases to a point where the increased ac output of V302 restores the high voltage to its original value.

4-48. HIGH-VOLTAGE RECTIFIER V304. (See figure 5-10.) The ac high voltage across the other secondary of transformer T301 is rectified by V304 and filtered by capacitor C310. The negative side of the high voltage is applied through resistor R327 to the control grid of the crt. The positive side of the high voltage is applied through resistor R326 to the horizontal sweep circuits, wherein the unblanking gate is generated. When the positive-going unblanking gate is generated, the crt control grid bias becomes less negative and the crt is unblanked.

## SECTION V MAINTENANCE

### 5-1. INTRODUCTION.

5-2. This section provides maintenance and service instructions for the Model 120B Oscilloscope. Included are troubleshooting, repair, adjustment, performance checks, and diagrams.

### 5-3. TEST EQUIPMENT.

5-4. Table 5-1 lists the test equipment required to maintain the Model 120B. Equipment with similar characteristics can be substituted.

### 5-5. TROUBLESHOOTING.

5-6. The troubleshooting procedures are divided into two categories: system troubleshooting, which is used

to isolate a malfunction to a particular functional section of the Model 120B; and sectional troubleshooting, which is used to locate the faulty detail part. Figures 5-1 through 5-4 show the location of parts whose designations are not directly imprinted on a circuit board or chassis.

### 5-7. SYSTEM TROUBLESHOOTING.

5-8. Most troubles occurring in the Model 120B will directly affect the display on the crt; consequently, the system-troubleshooting procedures are based on the most common types of faults detectable by crt observations. Table 5-2 lists the common types of defects that occur in oscilloscope displays, together with the circuits most likely to be at fault. After finding the faulty section, refer to the sectional troubleshooting procedures.

Table 5-1. Recommended Test Equipment

| Item No. | Type                      | Characteristics   | Use                         | Model No.  |
|----------|---------------------------|---|-----------------------------|--|
| 1        | Test Oscilloscope         | Bandwidth: dc to at least 600 kc. Sensitivity: 10 mv/cm to 100 v/cm.                                    | Observation of waveforms.   | Hewlett-Packard 140A.  |
| 2        | Precision DC Voltmeter    | Voltage range: 10-300 volts. Accuracy: $\pm 1\%$ . Input impedance: 1 megohm.                           | Voltage measurements.       | Hewlett-Packard Model 412A.  |
| 3        | High-Voltage DC Voltmeter | Voltage range: 3000 volts. Accuracy: 8%. Input impedance: 100 megohms.                                  | Voltage measurements.       | Hewlett-Packard Model 410C with Model 11045A Voltage Divider Probe |
| 4        | Audio Oscillator          | Frequency range: 50 cps to 450 kc.  | Source of sine-wave signal. | Hewlett-Packard Model 200CD.                                       |
| 5        | AC Voltmeter              | Voltage range: 1 mv to 300 v. Accuracy: 3%, depending on scale used. Frequency Range: 50 cps to 450 kc. | Voltage measurements.       | Hewlett-Packard Models 400D/H/L.                                   |

Table 5-1. Recommended Test Equipment (Cont'd)

| Item No. | Type                   | Characteristics   | Use                                    | Model No.                      |
|----------|------------------------|---|--|--------------------------------|
| 6        | Square Wave Generator  | Frequency range: 1 kc to 100 kc.<br>Rise time: Less than 0.2 $\mu$ sec.<br>Amplitude: To 50 volts peak-to-peak. | Source of square wave.                 | Hewlett-Packard Model 211A.    |
| 7        | Voltmeter Calibrator   | Accuracy: 0.5%.   | Accurate source of ac and dc voltages. | Hewlett-Packard Models 738A/B. |
| 8        | Time Mark Generator    | Marker intervals: decade steps from 10 $\mu$ sec to 100 msec.<br>Accuracy: 1%.                                  | Set sweep times.                       | Tektronix 180.                 |
| 9        | Power Auto-Transformer | Output voltage: 103-127 volts ac (for 115-volt input to 120B); 206-254 volts ac (for 230-volt input to 120B).   | Vary line voltage.                     | General Radio Type W10HM.      |
| 10       | Attenuator             | Attenuation: 110 db in 1-db steps.<br>Power capacity: 5 watts.  | Attenuation                            | Hewlett-Packard Model 350D.    |

## 5-9. SECTIONAL TROUBLESHOOTING.

5-10. GENERAL. Prior to troubleshooting any functional section, a visual inspection should be performed. Check for open fuse, broken wires, discolored parts, leaky capacitors, etc. The best method for checking tubes is by substitution.

5-11. HORIZONTAL AND VERTICAL AMPLIFIERS. In the event of vertical or horizontal troubles such as unbalance or no deflection, check plate voltages, starting at the input stage and working toward the crt. Be sure the position controls are centered, no signals are applied, and the HORIZONTAL DISPLAY switch is set to an external horizontal input position. Make detailed voltage checks (see paragraph 5-67) in the first stage with incorrect plate voltages. In the event of frequency response troubles, check tubes first (by substitution) then frequency-compensating devices such as trimmer capacitors, neutralizing and bypass capacitors.

5-12. SWEEP GENERATOR. With the exception of trigger generator V201, the sweep generator circuits form a feedback loop; consequently, a failure in any functional stage in the loop results in abnormal waveforms appearing in all stages of the loop. For this reason, voltage readings are the best means for locating troubles in the sweep generator circuit. Voltage measurements for both the start-of-sweep and end-of-sweep circuit conditions are listed on figure 5-8. In

the event of sweep failure, it is recommended that both voltage measurements be employed to isolate the trouble. A 10 to 15% deviation from the values given can be expected, a larger deviation indicates a source of trouble.

5-13. LOW-VOLTAGE POWER SUPPLY. When checking the power supplies, check the -150-volt supply first, for it affects all supplies. Check the other supplies in any order. Check all vacuum tubes and transistor Q301; if normal, make voltage checks (see paragraph 5-67). Voltage and ripple tolerances are given in table 5-4.

### CAUTION

Do not operate the Model 120B with incorrect power supply voltages for prolonged periods of time. Where the procedure calls for a measurement, turn the instrument on just long enough to make the measurement; then turn the instrument off again.

## 5-14. HIGH-VOLTAGE POWER SUPPLY.

### WARNING

Use caution when measuring high voltages. Use equipment suited for high-voltage measurements.



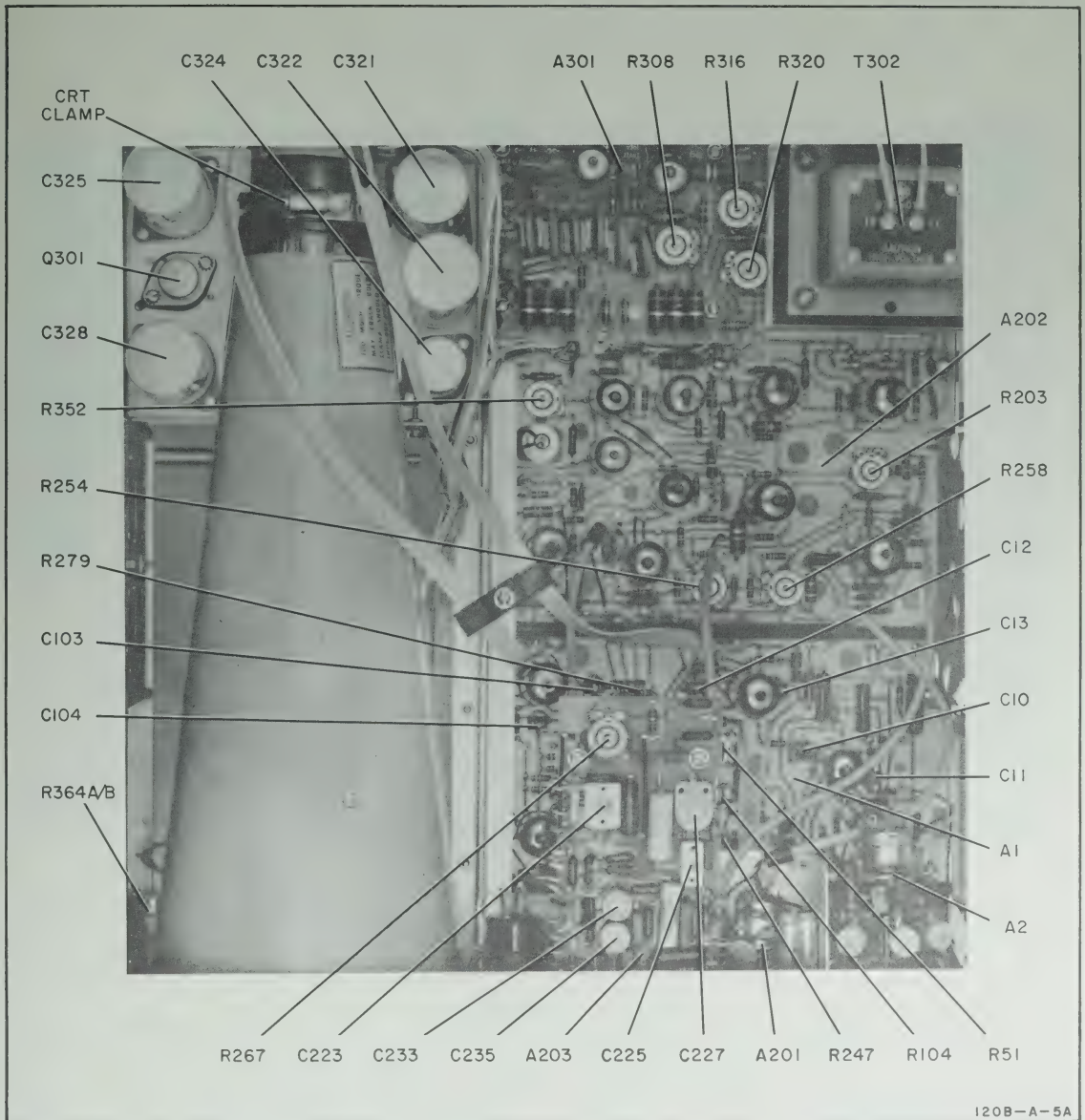


Figure 5-1. Top View, Location of Parts and Adjustments

5-15. Measure the voltages supplied to the crt. If they are normal, replace the crt. If the high voltages are not present, check that oscillator V302 is oscillating. Note that a fault in the crt cathode supply affects the crt grid supply, whereas a fault in the crt grid supply has no effect on the cathode supply. If both crt supplies are excessively high, or both excessively low, make voltage checks on V301 (see paragraph 5-67).

## Note

Do not reset high voltage adjustment R308 unless the need for such adjustment is clearly indicated. The adjustment of high voltages affects the sensitivity of the crt and makes necessary the readjustment of vertical and horizontal gain and time scales.

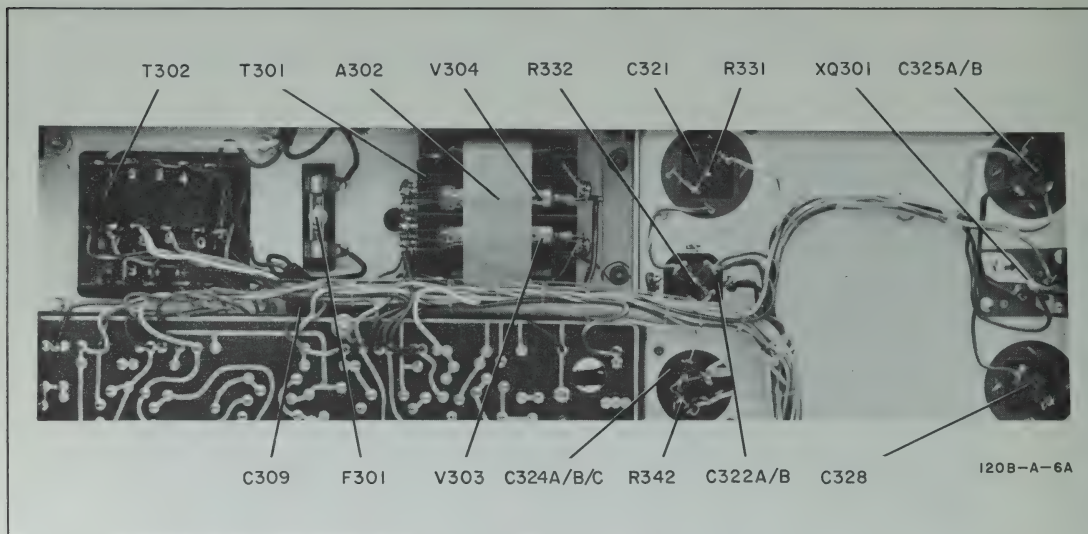


Figure 5-2. High-Voltage Power Supply, Location of Parts

Table 5-2. System Troubleshooting

| Symptom  | Probable Trouble   | Paragraph Reference   |
|--|--|---|
| Nothing visible on crt with BEAM FINDER pressed.   | <ol style="list-style-type: none"> <li>1. Low-voltage power supply.</li> <li>2. Vertical amplifier.</li> <li>3. Horizontal amplifier.</li> <li>4. High-voltage power supply.</li> <li>5. Crt.</li> </ol> | <ol style="list-style-type: none"> <li>1. Paragraphs 4-34 and 5-13</li> <li>2. Paragraphs 4-10 and 5-11</li> <li>3. Paragraphs 4-30 and 5-11</li> <li>4. Paragraphs 4-41 and 5-14</li> <li>5. Paragraph 5-21</li> </ol> |
| Vertical sensitivity out of specifications on all sensitivity ranges; horizontal sweep normal. | <ol style="list-style-type: none"> <li>1. Vertical amplifier.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Paragraphs 4-10 and 5-11</li> </ol>   |
| Vertical sensitivity out of specifications on one range.                                       | <ol style="list-style-type: none"> <li>2. VERTICAL SENSITIVITY switch S2.</li> </ol>   |   |
| External horizontal sensitivity out of specifications; vertical sensitivity normal.            | <ol style="list-style-type: none"> <li>1. Horizontal amplifier.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Paragraphs 4-30 and 5-11</li> </ol>   |
| Faulty sweep; external horizontal deflection normal.   | <ol style="list-style-type: none"> <li>1. Sweep generator circuits.</li> </ol>   | <ol style="list-style-type: none"> <li>1. Paragraphs 4-16 and 5-12</li> </ol>   |
| Poor focusing; intensity normal.   | <ol style="list-style-type: none"> <li>1. High-voltage power supply.</li> <li>2. Crt</li> </ol>  | <ol style="list-style-type: none"> <li>1. Paragraphs 4-41 and 5-14</li> <li>2. Paragraph 5-21</li> </ol>  |
| Poor intensity.  | <ol style="list-style-type: none"> <li>1. Low-voltage power supply.</li> <li>2. High-voltage power supply.</li> <li>3. Crt</li> </ol>  | <ol style="list-style-type: none"> <li>1. Paragraphs 4-34 and 5-13</li> <li>2. Paragraphs 4-41 and 5-14</li> <li>3. Paragraph 5-21</li> </ol>   |



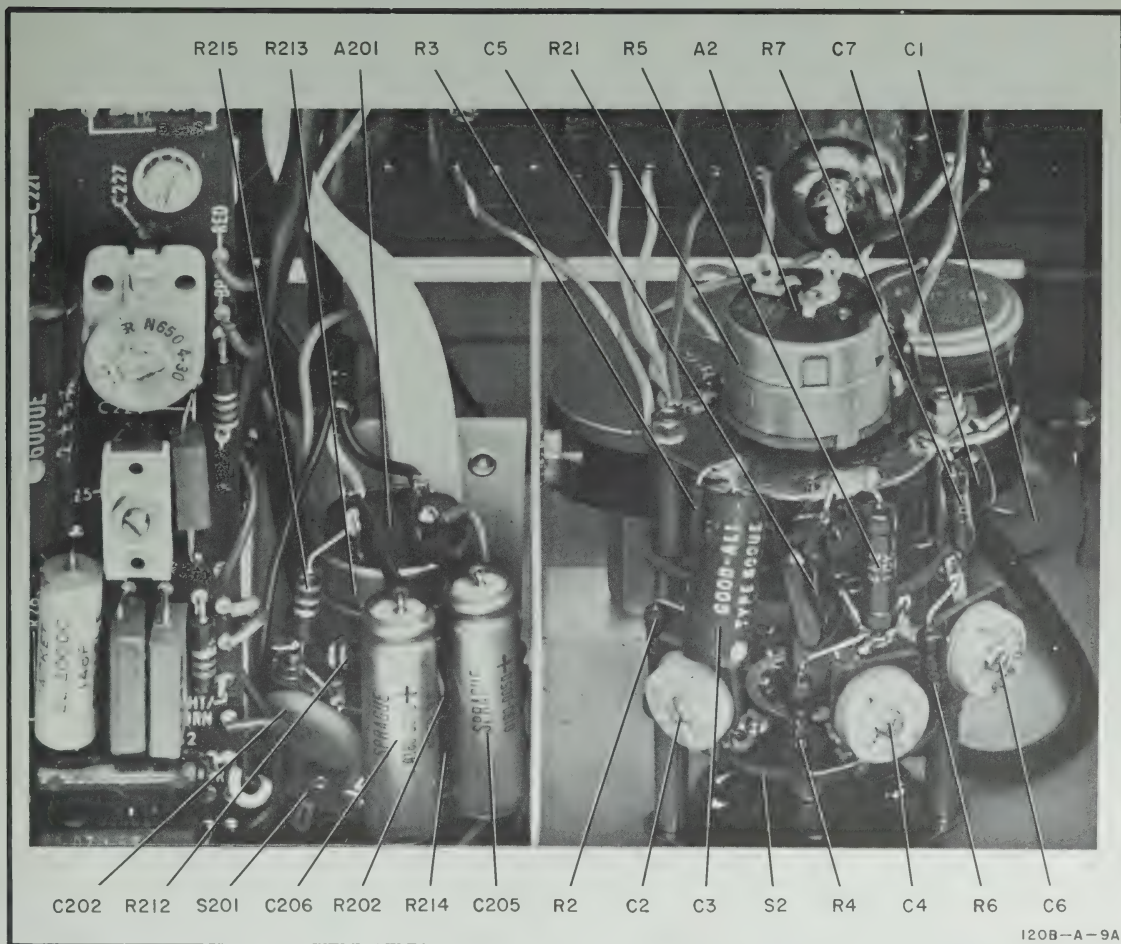


Figure 5-3. Vertical Sensitivity (A2) and Trigger Source (A201) Switches, Location of Parts and Adjustments

## 5-16. REPAIR.

### 5-17. REPLACEMENT OF SEMICONDUCTORS.

5-18. Excessive heat can destroy semiconductors. When soldering or unsoldering transistors or diodes, place a heat-sink (such as long-nose pliers) on the lead of the part; in addition, isolate the Model 120B from ground, or ground the body of the soldering iron to prevent leakage current from damaging the part.

#### Note

When replacing Q301, use a thin coat of silicone grease (hp Stock No. 8500-0059) on each side of the insulator to improve heat transfer from transistor to deck.

### 5-19. SERVICING ETCHED CIRCUIT BOARDS.

5-20. Figure 5-5 illustrates the recommended method of servicing etched circuit boards. Removal of

components, such as tube sockets, that are attached to the board at more than two points is difficult when trying to remove the part intact. Simplify the removal by first cutting the pins or other connections between the body of the part and the circuit board, and then remove the pins individually.

### 5-21. CRT REPLACEMENT.

#### WARNING

When replacing the crt, handle crt with care; wear gloves and plastic face mask or goggles.

5-22. Replace the crt as follows:

- Remove four mounting screws from bezel, and remove bezel.
- Loosen clamp screw (figure 5-1) on crt base; do not remove screw or clamp.



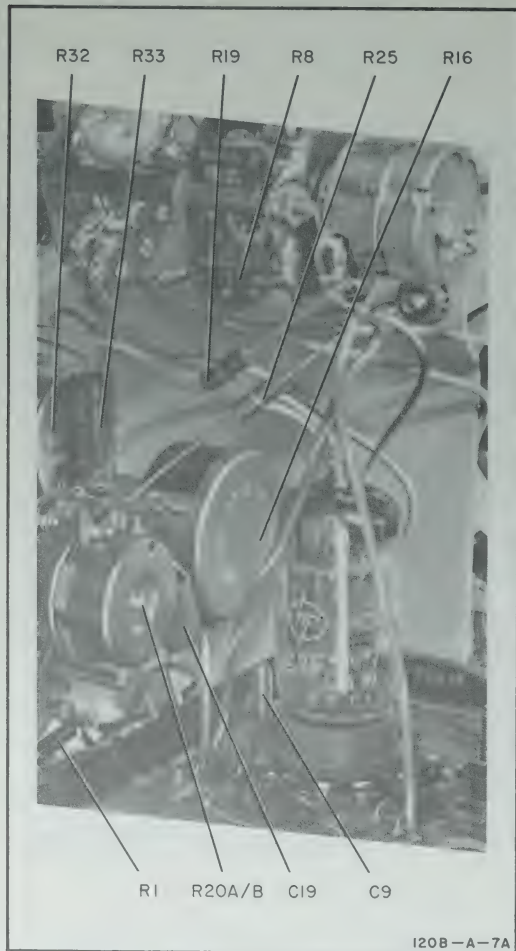


Figure 5-4. Right-Side View, Side Panel Removed, Location of Parts and Adjustments

- c. Remove socket from crt base.
- d. Slide crt forward and out.
- e. Replace in reverse order.
- f. Energize the Model 120B and obtain a free-running trace.
- g. If necessary, align graticule and trace by adjusting SCALE control.

## 5-23. ADJUSTMENTS.

### 5-24. ADJUSTMENTS FOLLOWING REPAIR.

5-25. Table 5-3 lists the adjustments required following the replacement of a tube, transistor, or diode. If a part associated with an item listed in the table is replaced, check the adjustment of the listed item.

5-26. The following paragraphs, 5-27 through 5-31, describe the adjustments necessary to align the Model 120B.

### 5-27. LOW-VOLTAGE POWER SUPPLY.

5-28. Table 5-4 lists the tolerances of the dc voltage outputs of the low-voltage power supply. If any voltage is not within tolerance it is probable that the line voltage is abnormal, a malfunction has occurred, or the replacement of a tube or part has caused the misadjustment. If it is confirmed that the power supply and line voltage are normal and the voltages are not within tolerance, adjustment is then required.

5-29. -150-VOLT ADJUSTMENT. Using a dc VTVM, adjust potentiometer R352 (figure 5-1) for -150 volts dc.

5-30. +19-VOLT ADJUSTMENT. There is no adjustment for the +19-volt output; if out of tolerance a faulty transistor or part is indicated, or a fault exists in the -150-volt power supply.

5-31. +300-VOLT ADJUSTMENT. There is no adjustment for the +300-volt output; if out of tolerance a faulty tube or part is indicated, or a fault exists in the -150-volt power supply.

5-32. +100- AND +99-VOLT ADJUSTMENT. There is no adjustment for these outputs; if out of tolerance a faulty tube or part is indicated, or a fault exists in the -150-volt power supply.

#### Note

If the +300 volts dc is within tolerance and the +100 and/or +99 volts dc are not within tolerance, a fault exists in V308 or associated parts.

### 5-33. HIGH-VOLTAGE POWER SUPPLY.

5-34. Adjust the high-voltage power supply as follows:

#### Note

Adjustment of the high voltage affects crt deflection sensitivity, intensity, focus, and astigmatism. Check horizontal and vertical gain adjustments following any adjustment of the high voltage. Intensity, focus, and astigmatism adjustments are included in the following adjustment of the high-voltage power supply.

#### WARNING

Voltages in excess of 2,500 volts are present in the high-voltage power supply. Take all possible precautions when performing high-voltage measurements.

- a. Connect high-voltage voltmeter between terminal 17 or 18 of transformer T302 and ground.
- b. Adjust potentiometer R308 (figure 5-1) for a voltmeter reading of -2500 volts.

## SERVICING ETCHED CIRCUIT BOARDS

Excessive heat or pressure can lift the copper strip from the board. Avoid damage by using a low power soldering iron (50 watts maximum) and following these instructions. Copper that lifts off the board should be cemented in place with a quick drying acetate base cement having good electrical insulating properties.

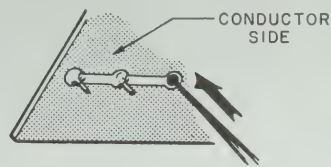
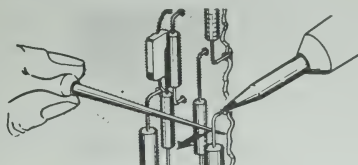
A break in the copper should be repaired by soldering a short length of tinned copper wire across the break.

Use only high quality rosin core solder when repairing etched circuit boards. NEVER USE PASTE FLUX. After soldering, clean off any excess flux and coat the repaired area with a high quality electrical varnish or lacquer.

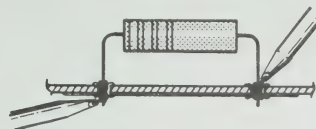
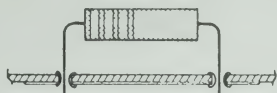
When replacing components with multiple mounting pins such as tube sockets, electrolytic capacitors, and potentiometers, it will be necessary to lift each pin slightly, working around the components several times until it is free.

**WARNING:** If the specific instructions outlined in the steps below regarding etched circuit boards without eyelets are not followed, extensive damage to the etched circuit board will result.

1. Apply heat sparingly to lead of component to be replaced. If lead of component passes through an eyelet in the circuit board, apply heat on component side of board. If lead of component does not pass through an eyelet, apply heat to conductor side of board.
2. Reheat solder in vacant eyelet and quickly insert a small awl to clean inside of hole. If hole does not have an eyelet, insert awl or a #57 drill from conductor side of board.

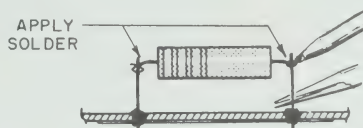
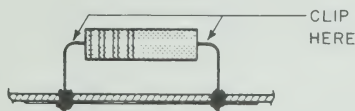


3. Bend clean tinned leads on new part and carefully insert through eyelets or holes in board.
4. Hold part against board (avoid overheating) and solder leads. Apply heat to component leads on correct side of board as explained in step 1.



In the event that either the circuit board has been damaged or the conventional method is impractical, use method shown below. This is especially applicable for circuit boards without eyelets.

1. Clip lead as shown below.
2. Bend protruding leads upward. Bend lead of new component around protruding lead. Apply solder using a pair of long nose pliers as a heat sink.



This procedure is used in the field only as an alternate means of repair. It is not used within the factory.

Figure 5-5. Servicing Etched Circuit Boards

Table 5-3. Adjustments Following Tube, Transistor, and Diode Replacement

| Reference Designation | Function                                 | Adjustment and Paragraph   |
|-----------------------|--|--|
| Vertical Amplifier    |  |  |
| V1                    | Amplifier                                | 1. Balance adjustment (figure 3-5)<br>2. Gain adjustment (paragraph 5-37)<br>3. Neutralization adjustment (paragraphs 5-38 and 5-40) |
| V2                    | Amplifier                                | 1. Balance adjustment (figure 3-5)<br>2. Gain adjustment (paragraph 5-37)<br>3. Neutralization adjustment (paragraphs 5-39 and 5-40) |
| V3                    | Amplifier                                | 1. Balance adjustment (figure 3-5)<br>2. Gain adjustment (paragraph 5-37)<br>3. Neutralization adjustment (paragraph 5-39)           |
| V4                    | Calibrator                               | None   |
| V5                    | Calibrator                               | 1. Calibrator adjustment (paragraph 5-41)  |
| Horizontal Amplifier  |  |  |
| V101                  | Amplifier                                | 1. Gain adjustment (paragraph 5-43)<br>2. X1 Sweep adjustment (paragraph 5-49)<br>3. Neutralization adjustment (paragraph 5-44)      |
| V102                  | Amplifier                                | 1. Gain adjustment (paragraph 5-43)<br>2. X1 Sweep adjustment (paragraph 5-49)<br>3. Neutralization adjustment (paragraph 5-44)      |
| Sweep Generator       |  |  |
| V201                  | Trigger generator                        | Trigger sensitivity adjustment (paragraph 5-47)  |
| V202                  | Start-stop trigger                       | Preset adjustment (paragraph 5-46)   |
| V203                  | Clamp and hold-off cathode follower      | None   |
| V204                  | Gate-out cathode follower                | None   |
| V205                  | Sawtooth integrator and cathode follower | Sweep time adjustment (paragraph 5-50)   |
| V206                  |  | Preset adjustment (paragraph 5-46)   |
| V207                  |  | Sweep length adjustment (paragraph 5-51)   |
| V208                  |  | None   |
| V209                  |  | None   |
| CR201                 | Switch diode                             | None   |



Table 5-3. Adjustments Following Tube, Transistor, and Diode Replacement (Cont'd)

| Reference Designation     | Function                          | Adjustment and Paragraph  |
|---------------------------|-----------------------------------|---|
| High-Voltage Power Supply |                                   |   |
| V301                      | Amplifier                         | Adjust horizontal gain (paragraph 5-43)<br>Adjust vertical gain (paragraph 5-37)<br>Adjust sweep times (paragraph 5-48) |
| V302                      | Oscillator                        |   |
| V303                      | Rectifier                         |   |
| V304                      | Rectifier                         |   |
| V305                      | CRT                               |   |
| Low-Voltage Power Supply  |                                   |   |
| V307                      | Regulator                         | None  |
| V308                      | Amplifier-output cathode follower | None  |
| V309                      | Regulator                         | None  |
| V310                      | Amplifier                         | Adjust -150 volts (paragraph 5-29)  |
| V311                      | Reference tube                    | Adjust -150 volts (paragraph 5-29)  |
| Q301                      | Heater regulator                  | None  |
| CR301-CR304               | Rectifiers                        | None  |
| CR305                     | Reference diode                   | None  |

Table 5-4. Low-Voltage Power Supply Voltages

| Voltage**     | Tolerance*                  | Typical** Ripple | Typical** Resistance   |
|---------------|-----------------------------|------------------|------------------------|
| -150 volts dc | VTVM Accuracy ( $\pm 3\%$ ) | 5 mv             | 10K                    |
| + 19 volts dc | -1.5 volts; +1 volt         | 45 mv            | 4K (with V101 removed) |
| +300 volts dc | $\pm 9$ volts               | 45 mv            | 75K                    |
| +100 volts dc | $\pm 3$ volts               | 15 mv            | 50K                    |
| + 99 volts dc | $\pm 3$ volts               | 15 mv            |                        |

\*Line voltage 115 or 230 volts ac, as required.

\*\*With respect to chassis ground.

c. Switch **HORIZONTAL DISPLAY** to **1 VOLTS/CM** and center the spot.d. Set **INTENSITY** control to 9 o'clock and adjust R320 (figure 5-1) to the point where the spot just extinguishes.e. Increase **INTENSITY** control and adjust **FOCUS** control for best spot.f. Adjust **Astigmatism** control R316 (figure 5-1) for small round spot readjusting **FOCUS** control as required.**5-35. VERTICAL AMPLIFIER.**5-36. **BALANCE ADJUSTMENT.** Adjust the vertical amplifier balance as described in figure 3-5.5-37. **GAIN ADJUSTMENT.** Adjust the vertical amplifier gain as follows:a. Set **VERTICAL SENSITIVITY** to **10 MILLI-VOLTS/CM.**

- b. Set vertical VERNIER to CAL.
- c. Using voltmeter calibrator, apply a 400-cps 0.1-volt peak-to-peak signal to the vertical input terminals.
- d. Adjust CAL screwdriver adjustment for a crt deflection of 10 cm.

5-38. ATTENUATOR - FREQUENCY - COMPENSATION AND FIRST-STAGE-NEUTRALIZATION ADJUSTMENTS. Adjust the vertical amplifier attenuator-frequency compensation and first-stage neutralization as follows:

- a. Connect square-wave generator to the vertical input terminals.
- b. Rotate vertical VERNIER fully counterclockwise.
- c. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.
- d. Set vertical AC-DC to AC.
- e. Set HORIZONTAL DISPLAY to 0.5 MSEC/CM.
- f. Adjust output of generator to 1 kc and set amplitude for 10 cm of deflection on crt.
- g. Adjust capacitor C6 (figure 5-3) for best square-wave pattern on crt.
- h. Rotate vertical VERNIER to CAL.
- i. Readjust square-wave generator for 10 cm of deflection on crt.
- j. Adjust C9 (figure 5-4) for best square-wave pattern on crt.
- k. Repeat adjustment of C6 and C9 until best square-wave pattern is obtained at the extreme vernier settings.

Note

There may be a capacitor in parallel with C9 which serves to optimize the adjustment range of C9. When changing V1 it may be necessary to alter the value of the capacitor, or add it if not present.

- l. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.
- m. Readjust square-wave generator for 10 cm of deflection on crt.
- n. Adjust capacitor C4 (figure 5-3) for best square-wave pattern on crt.
- o. Set VERTICAL SENSITIVITY to 10 VOLTS/CM.
- p. Readjust square-wave generator for 10 cm of deflection on crt.
- q. Adjust capacitor C2 (figure 5-3) for best square-wave pattern on crt.

5-39. THIRD-STAGE VERTICAL-NEUTRALIZATION ADJUSTMENT. Adjust the third-stage vertical neutralizers as follows:

- a. Rotate vertical VERNIER fully counterclockwise.
- b. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.
- c. Set vertical AC-DC to AC.
- d. Set HORIZONTAL DISPLAY to 5  $\mu$ SEC/CM.
- e. Set TRIGGER SOURCE to INT+.
- f. Turn TRIGGER LEVEL to AUTO.
- g. Using square-wave generator, apply a 100-kc square wave to vertical input terminals.
- h. Adjust generator output to give 10-cm deflection, and center the pattern vertically.
- i. Using test oscilloscope, monitor the cathode of V3.

- j. Adjust C12 and C13 (figure 5-1) simultaneously, for the best square wave on both test oscilloscope and scope under test.

Notes

Ignore the very fast overshoot at the leading edge as viewed on monitor scope.

There may be a capacitor in parallel with C13 which serves to optimize the adjustment range of C13. When changing V2 or V3 it may be necessary to alter the value of the capacitor, or add it if not present.

5-40. SECOND-STAGE VERTICAL NEUTRALIZATION ADJUSTMENT. Adjust the second-stage vertical neutralizers as follows:

- a. Rotate vertical VERNIER to CAL.
- b. Repeat steps b through h of paragraph 5-39.
- c. Adjust C10 and C11 (figure 5-1) simultaneously for best square wave on scope.

Note

There may be a capacitor in parallel with C10 which serves to optimize the adjustment range of C10. When changing V1 or V2 it may be necessary to alter the value of the capacitor, or to add it if not present.

5-41. CALIBRATOR ADJUSTMENT. Adjust the output of the calibrator as follows:

- a. Adjust vertical gain as described in paragraph 5-37.
- b. Set VERTICAL SENSITIVITY to CAL.
- c. Turn vertical VERNIER to CAL.
- d. Set HORIZONTAL DISPLAY to 1 MILLISECONDS/CM.
- e. Set TRIGGER SOURCE to INT-.
- f. Turn TRIGGER LEVEL to AUTO.
- g. Adjust potentiometer R51 (figure 5-1) for a crt deflection of 6 cm.

5-42. HORIZONTAL AMPLIFIER.

5-43. GAIN ADJUSTMENT. Adjust horizontal gain as follows:

- a. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Using voltmeter calibrator, apply a 400-cps 1-volt peak-to-peak signal to the horizontal input terminals.
- d. Adjust horizontal gain potentiometer R104 (figure 5-1) for a peak-to-peak crt deflection of 10 cm.

5-44. HORIZONTAL NEUTRALIZER ADJUSTMENT. Adjust horizontal neutralization as follows:

- a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- d. Turn horizontal VERNIER to CAL.

e. Using oscillator, apply an 8-kc sine wave to vertical input terminals and the sync input of square-wave generator.

f. Using square-wave generator, apply a 100-kc 1-volt peak-to-peak square wave to horizontal input terminals.

g. Adjust oscillator frequency to synchronize sine wave and square wave on crt (stabilize presentation).

h. Adjust C103 and C104 (figure 5-1) for best square-wave response.

**5-45. ATTENUATOR FREQUENCY-COMPENSATION ADJUSTMENT.** Adjust the horizontal attenuator frequency compensation as follows:

a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Turn horizontal VERNIER to CAL.

d. Set HORIZONTAL DISPLAY to 1 VOLTS/CM.

e. Using square-wave generator, apply a 1-kc 10-volt peak-to-peak square wave to the horizontal input terminals.

f. Using oscillator, apply an 800-cps 10-volt peak-to-peak signal to the vertical input and sync input of square-wave generator.

g. Adjust oscillator to synchronize sine wave and square wave on crt (stabilize presentation).

h. Adjust capacitor C235 (figure 5-1) for optimum square wave on crt.

i. Set HORIZONTAL DISPLAY to 10 VOLTS/CM.

j. Increase square-wave generator output to 50 volts peak-to-peak.

k. Adjust capacitor C233 (figure 5-1) for optimum square-wave on crt.

**5-46. PRESET ADJUSTMENT.** Adjust preset as follows:

a. Set VERTICAL SENSITIVITY to CAL.

b. Set HORIZONTAL DISPLAY to .5 MILLISECONDS/CM.

c. Set TRIGGER SOURCE to INT+.

d. Turn TRIGGER LEVEL just out of AUTO.

e. Connect dc voltmeter (-100-volt range) between pin 2 of V202 and ground.

f. Adjust potentiometer R258 (figure 5-1) clockwise until crt sweep free-runs, then counterclockwise until the sweep just stops; note the readings on the voltmeter.

g. Adjust voltage to 3 volts less negative than the last reading.

**5-47. TRIGGER-SENSITIVITY ADJUSTMENT.** Adjust the trigger sensitivity as follows:

a. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

b. Set HORIZONTAL DISPLAY to 5 MILLISECONDS/CM.

c. Turn both VERNIER controls to CAL.

d. Set TRIGGER SOURCE to EXT.

e. Turn TRIGGER LEVEL to AUTO.

f. Set SWEEP MAGNIFIER to X5.

g. Set vertical and horizontal AC-DC switches to AC.

h. Connect oscillator to both the VERTICAL and HORIZONTAL inputs and set the frequency to 450 kc and amplitude to 0.16 volts rms (using hp Model 400D/H/L AC VTVM).

i. Adjust R203 (trigger sensitivity) fully counterclockwise.

j. Observing crt presentation, adjust R203 clockwise until the presentation becomes stable.

k. Adjust oscillator output amplitude down to 0.1 v rms, presentation should become slightly unstable between 0.15 and 0.10 v rms.

l. Set oscillator output amplitude to 0.5 v rms, and adjust frequency from 50 cps to 450 kc. Presentation should remain stable across complete frequency range.

#### 5-48. SWEEP GENERATOR.

**5-49. X1 SWEEP ADJUSTMENT.** Adjust the X1 sweep as follows:

a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Turn horizontal VERNIER to CAL.

d. Set HORIZONTAL DISPLAY to 5 MILLISECONDS/CM.

e. Set SWEEP MAGNIFIER to X1.

f. Set TRIGGER SOURCE to INT-.

g. Turn TRIGGER LEVEL to AUTO.

h. Using time mark generator, apply 100-cps time markers to the vertical input terminals.

i. Adjust X1 sweep gain R267 (figure 5-1) to obtain 5 cycles per 10 cm on the crt.

**5-50. SWEEP-TIME ADJUSTMENT.** Adjust the horizontal sweep time as follows:

a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Turn horizontal VERNIER to CAL.

d. Set TRIGGER SOURCE to INT-.

e. Set SWEEP MAGNIFIER to X1.

f. Connect time mark generator to the vertical input terminals.

g. Referring to table 5-5, adjust the time mark generator output and the HORIZONTAL DISPLAY switch to the indicated marker interval and sweep time, respectively, for each step; adjust or check for the indicated markers per 10 cm listed in the table.

**5-51. SWEEP LENGTH ADJUSTMENT.** Adjust the sweep length as follows:

a. Set VERTICAL SENSITIVITY to 100 MILLIVOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Set vertical AC-DC to AC.

d. Set HORIZONTAL DISPLAY to .5 MILLISECONDS/CM.

e. Turn horizontal VERNIER to CAL.

f. Set SWEEP MAGNIFIER to X1.

g. Set TRIGGER SOURCE to INT-.

h. Turn TRIGGER LEVEL to AUTO.

i. Adjust potentiometer R254 (figure 5-1) for a sweep length of 10.75 cm (minimum length on any range should be 10.5 cm).

#### 5-52. PERFORMANCE CHECK.

**5-53.** The following paragraphs, 5-54 through 5-66, list the various performance checks to determine that the Model 120B is performing properly.

**5-54. VERTICAL ATTENUATOR-ERROR CHECK.** Check the vertical attenuator error as follows:

a. Set vertical AC-DC to DC.

b. Set VERTICAL SENSITIVITY to 10 MILLIVOLTS/CM.

c. Turn vertical VERNIER to CAL.



Table 5-5. Horizontal Sweep-Time Adjustment

| Step | Marker Interval | Sweep Time          | Adjust | Markers per 10 cm |
|------|-----------------|---------------------|--------|-------------------|
| 1    | 10 $\mu$ sec    | 5 $\mu$ SEC/CM      | C227   | 5                 |
| 2    | 10 $\mu$ sec    | 10 $\mu$ SEC/CM     | C227 * | 10                |
| 3    | 10 $\mu$ sec    | 20 $\mu$ SEC/CM     | C227 * | 20                |
| 4    | 100 $\mu$ sec   | 50 $\mu$ SEC/CM     | C225   | 5                 |
| 5    | 100 $\mu$ sec   | 100 $\mu$ SEC/CM    | C225 * | 10                |
| 6    | 100 $\mu$ sec   | 200 $\mu$ SEC/CM    | C225 * | 20                |
| 7    | 1 ms            | .5 MILLISECONDS/CM  | C223   | 5                 |
| 8    | 1 ms            | 1 MILLISECONDS/CM   | C223 * | 10                |
| 9    | 1 ms            | 2 MILLISECONDS/CM   | C233 * | 20                |
| 10   | 10 ms           | 5 MILLISECONDS/CM   | R267   | 5                 |
| 11   | 10 ms           | 10 MILLISECONDS/CM  | R267 * | 10                |
| 12   | 10 ms           | 20 MILLISECONDS/CM  | R267 * | 20                |
| 13   | 100 ms          | 50 MILLISECONDS/CM  | R247   | 5                 |
| 14   | 100 ms          | 100 MILLISECONDS/CM | R247 * | 10                |
| 15   | 100 ms          | 200 MILLISECONDS/CM | R247 * | 20                |

\* Do not adjust if indication is within  $\pm 0.5$  cm of that listed in the "markers per 10 cm" column.

d. Using voltmeter calibrator, apply a 400-cps 0.1-volt peak-to-peak signal to the vertical input terminals.

e. Adjust CAL for a crt deflection of exactly 10 cm.  
f. Set VERTICAL SENSITIVITY to 100 MILLI-VOLTS/CM.

g. Adjust voltmeter calibrator output to 1 volt peak-to-peak.

h. Vertical deflection should be  $10 \pm 0.3$  cm. Repeat step for 1 and 10 volts/cm positions of VERTICAL SENSITIVITY switch, adjusting voltmeter calibrator output to 10 and 100 volts peak-to-peak, respectively; vertical deflection should be  $10 \pm 0.3$  cm in both cases.

5-55. VERTICAL DC SHIFT CHECK. Check the dc shift as follows:

a. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM.

b. Set vertical AC-DC to AC.

c. Turn vertical VERNIER to CAL.

d. Short vertical input terminals to ground.

e. Switch HORIZONTAL DISPLAY to 10 VOLTS/CM, and observe the spot.

f. Switch vertical AC-DC switch to DC, and observe the spot.

g. Vertical shift should be approximately 0.2 cm or less.

5-56. VERTICAL FREQUENCY-RESPONSE CHECK. Check vertical frequency response as follows:

a. Set VERTICAL SENSITIVITY to 10 MILLI-VOLTS/CM.

b. Turn vertical VERNIER to CAL.

c. Set vertical AC-DC to AC.

d. Set TRIGGER SOURCE to INT+.

e. Turn TRIGGER LEVEL to AUTO.

f. Set HORIZONTAL DISPLAY to 1 MILLISECONDS/CM.

g. Using oscillator, apply a 4.5-kc signal to the input of attenuator; adjust for 10-db of attenuation.

h. Connect the output of attenuator to the vertical input terminals.

i. Set oscillator output to provide 10 cm of vertical deflection.

j. Monitor output with ac voltmeter and note voltage reading.

k. Maintaining voltage reading in step j, change oscillator frequency to 450 kc.

l. Display amplitude should be at least 7 cm peak-to-peak.

5-57. HORIZONTAL DC SHIFT CHECK. Check dc shift as follows:

- a. Set HORIZONTAL SENSITIVITY to .1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Short horizontal input terminals.
- d. Center spot and alternately switch horizontal AC-DC to AC and DC positions.
- e. Spot should shift less than 0.2 cm.

5-58. HORIZONTAL ATTENUATOR-ERROR CHECK. Check attenuator error as follows:

- a. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Using voltmeter calibrator, apply a 400-cps 1-volt peak-to-peak sine wave to the horizontal input terminals.
- d. Adjust horizontal gain potentiometer R104 (figure 5-1) to give 10-cm deflection.
- e. Change HORIZONTAL DISPLAY to 1 VOLTS/CM and voltmeter calibrator output to 10 volts peak-to-peak.
- f. Horizontal deflection should be  $10 \pm 0.5$  cm.
- g. Change HORIZONTAL SENSITIVITY to 10 VOLTS/CM and voltmeter calibrator output to 100 volts peak-to-peak.
- h. Horizontal deflection should be  $10 \pm 0.5$  cm.

5-59. HORIZONTAL PHASE-SHIFT CHECK. Check phase shift as follows:

- a. Set VERTICAL SENSITIVITY to 100 MILLI-VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to .1 VOLTS/CM.
- d. Turn horizontal VERNIER to CAL.
- e. Set vertical and horizontal AC-DC to AC.
- f. Using oscillator, apply a 100-kc 0.5-volt peak-to-peak sine wave to both vertical and horizontal input terminals.
- g. Pattern opening on crt should be less than 0.2 cm ( $\pm 2$  degrees).
- h. Change VERTICAL SENSITIVITY to 1 VOLTS/CM, HORIZONTAL DISPLAY to 1 VOLTS/CM, and voltmeter calibrator output to 5 volts peak-to-peak.
- i. Indication should be same as step g.
- j. Change VERTICAL SENSITIVITY to 10 VOLTS/CM, HORIZONTAL DISPLAY to 10 VOLTS/CM, and voltmeter calibrator output to 50 volts peak-to-peak.
- k. Indication should be same as step g.

5-60. HORIZONTAL RESPONSE CHECK. Check frequency response as follows:

- a. Set HORIZONTAL DISPLAY to 1 VOLTS/CM.
- b. Turn horizontal VERNIER to CAL.
- c. Using oscillator, apply a 4.5-kc signal to the horizontal input terminals.
- d. Set oscillator output to provide a 10-cm trace.
- e. Monitor output with ac voltmeter and note voltage reading.
- f. Maintaining voltage reading in step e, change oscillator frequency to 300 kc.
- g. Trace length should be greater than 7 cm (3-db point).

5-61. EXTERNAL TRIGGER-SENSITIVITY CHECK. Check external trigger sensitivity as follows:

- a. Set VERTICAL SENSITIVITY to 1 VOLTS/CM.

- b. Set vertical AC-DC to AC.
- c. Turn vertical VERNIER to CAL.
- d. Set HORIZONTAL DISPLAY to  $5 \mu\text{SEC/CM}$ .
- e. Set TRIGGER SOURCE to EXT.
- f. Set TRIGGER LEVEL to AUTO.
- g. Using oscillator, apply a sine wave to both the vertical and horizontal input terminals.
- h. Vary oscillator frequency from 50 cps to 450 kc, maintaining a 0.53-volt input (1.5 volts peak-to-peak).
- i. Presentation should be stable over frequency range in step h.

5-62. SYNC-POLARITY AND TRIGGER-LEVEL-RANGE CHECK. Check sync polarity and trigger-level range as follows:

- a. Set VERTICAL SENSITIVITY to 10 VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set TRIGGER SOURCE to EXT.
- d. Apply a 7.0-volt r-m-s 400-cps signal to vertical and external sync inputs.
- e. Center pattern on crt.
- f. Rotate TRIGGER LEVEL; triggering should be possible at any point along the negative slope of the input signal.

5-63. SWEEP-TIME CHECK. Check the sweep times as follows:

- a. Set VERTICAL SENSITIVITY to 1 VOLT/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set horizontal VERNIER to CAL.
- d. Set SWEEP MAGNIFIER to X1.
- e. Set TRIGGER SOURCE to INT-.
- f. Adjust TRIGGER LEVEL for best synchronization.
- g. Connect time mark generator to vertical input terminals.
- h. Referring to table 5-6, adjust the time mark generator output and the HORIZONTAL DISPLAY switch to the indicated markers and setting, respectively, for each step; check for the indicated markers per 10 cm listed in the table.

5-64. CALIBRATOR AMPLITUDE CHECK. Check the amplitude of the calibrator as follows:

- a. Set VERTICAL SENSITIVITY to CAL.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to 1 MILLI-SEC/CM.
- d. Set TRIGGER SOURCE to INT-.
- e. Turn TRIGGER LEVEL to AUTO.
- f. Calibrator amplitude should be  $6 \pm 0.12$  cm.

5-65. INTENSITY MODULATION CHECK. Check intensity modulation as follows:

- a. Set VERTICAL SENSITIVITY to 10 VOLTS/CM.
- b. Turn vertical VERNIER to CAL.
- c. Set HORIZONTAL DISPLAY to  $50 \mu\text{SECONDS/CM}$ .
- d. Using square-wave generator, apply a 50-kc 20-volt peak-to-peak square wave to the vertical input terminals.
- e. Remove shorting bar from Z axis terminal and connect clip lead from vertical input to Z axis terminal.
- f. With normal intensity, the top edge of square wave should be extinguished when 20-volt peak-to-peak square wave is applied at the Z axis terminal.

Table 5-6. Horizontal Sweep Time

| Step | Marker Interval | Sweep Time          | Markers per 10 cm* |
|------|-----------------|---------------------|--------------------|
| 1    | 10 $\mu$ sec    | 5 $\mu$ SEC/CM      | 5                  |
| 2    | 10 $\mu$ sec    | 10 $\mu$ SEC/CM     | 10                 |
| 3    | 10 $\mu$ sec    | 20 $\mu$ SEC/CM     | 20                 |
| 4    | 100 $\mu$ sec   | 50 $\mu$ SEC/CM     | 5                  |
| 5    | 100 $\mu$ sec   | 100 $\mu$ SEC/CM    | 10                 |
| 6    | 100 $\mu$ sec   | 200 $\mu$ SEC/CM    | 20                 |
| 7    | 1 ms            | .5 MILLISECONDS/CM  | 5                  |
| 8    | 1 ms            | 1 MILLISECONDS/CM   | 10                 |
| 9    | 1 ms            | 2 MILLISECONDS/CM   | 20                 |
| 10   | 10 ms           | 5 MILLISECONDS/CM   | 5                  |
| 11   | 10 ms           | 10 MILLISECONDS/CM  | 10                 |
| 12   | 10 ms           | 20 MILLISECONDS/CM  | 20                 |
| 13   | 100 ms          | 50 MILLISECONDS/CM  | 5                  |
| 14   | 100 ms          | 100 MILLISECONDS/CM | 10                 |
| 15   | 100 ms          | 200 MILLISECONDS/CM | 20                 |

\*  $\pm 0.5$  cm

5-66. LINE-VOLTAGE VARIATION CHECK. Check line-voltage variation as follows:

a. Connect power cable to power autotransformer and adjust output to 115 volts ac.

b. Set VERTICAL SENSITIVITY to CAL.

c. Set HORIZONTAL DISPLAY to 2 MILLISECONDS/CM.

d. Set TRIGGER LEVEL to AUTO.

e. Adjust horizontal VERNIER to obtain exactly 5 cycles of calibrator signal per 10 cm; note exact amplitude of each calibrator signal.

f. Set line voltage to 103 volts ac, then to 127 volts ac. (Allow periods of at least 2 minutes for each voltage.) Calibrator signal amplitude should be  $\pm 0.3$  cm; the five cycles of the signal should change less than 0.5 cm in length.

d. Voltage measurements are made with Model 120B front-panel controls set as follows:

| Control                     | Setting        |
|-----------------------------|----------------|
| VERTICAL SENSITIVITY switch | CAL            |
| VERTICAL VERNIER control    | CAL            |
| Vertical AC-DC switch       | AC             |
| FOCUS control               | Centered       |
| VERTICAL POSITION control   | Centered       |
| INTENSITY control           | Centered       |
| HORIZONTAL POSITION control | Centered       |
| HORIZONTAL DISPLAY switch   | 5 $\mu$ SEC/CM |
| HORIZONTAL VERNIER control  | CAL            |
| TRIGGER SOURCE switch       | INT-           |
| TRIGGER LEVEL control       | AUTO           |
| Horizontal AC-DC switch     | AC             |
| SWEEP MAGNIFIER switch      | X1             |

## 5-67. DIAGRAMS.

5-68. Figures 5-6 through 5-11 are schematic diagrams of the Model 120B. DC voltages are provided on the schematics as an aid in troubleshooting.

5-69. The following notations are applicable to figures 5-6 through 5-11.

a. All values are in ohms, picofarads, and microhenries unless otherwise indicated.

b. Lettering enclosed in heavy boxes indicates front-panel engraving.

c. Voltage measurements are with respect to ground and made with Hewlett-Packard Model 412A VTVM.



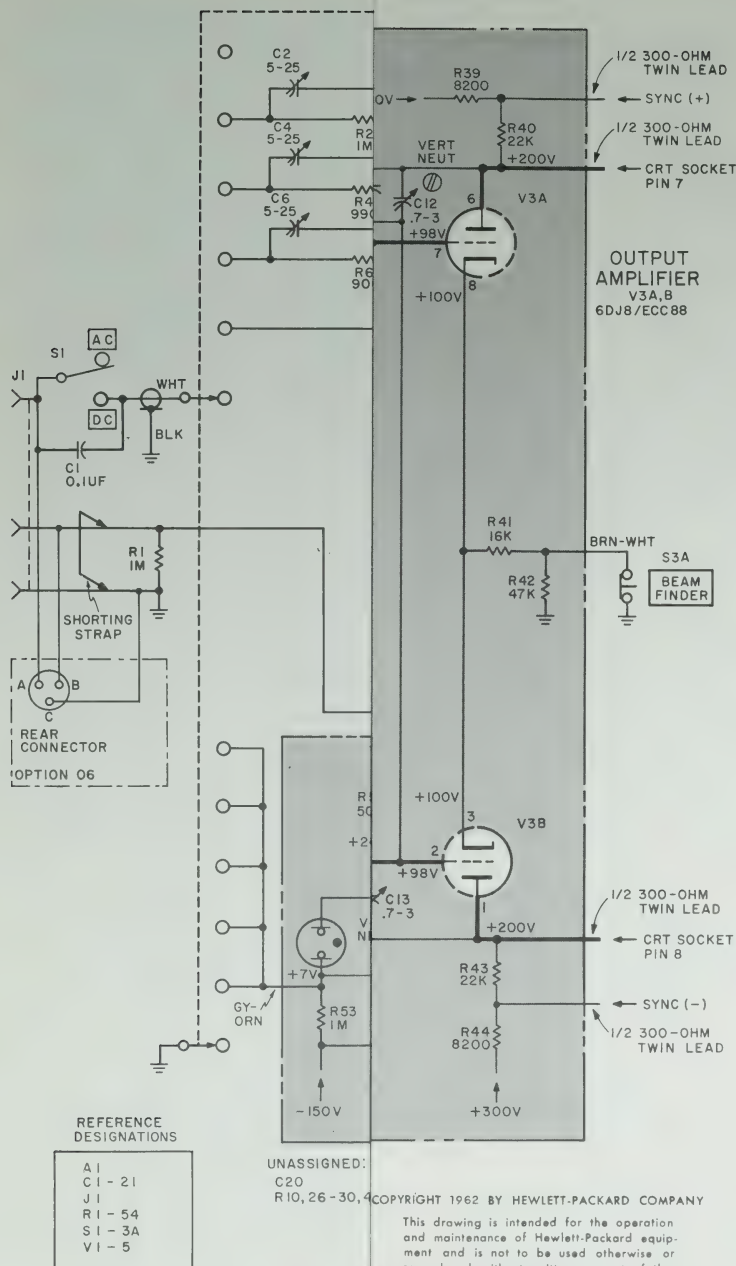


Figure 5-6. Vertical Amplifier

Table 5-6. Horizontal Sweep Time

| Step | Marker Interval | Sweep Time          | Markers per 10 cm* |
|------|-----------------|---------------------|--------------------|
| 1    | 10 $\mu$ sec    | 5 $\mu$ SEC/CM      | 5                  |
| 2    | 10 $\mu$ sec    | 10 $\mu$ SEC/CM     | 10                 |
| 3    | 10 $\mu$ sec    | 20 $\mu$ SEC/CM     | 20                 |
| 4    | 100 $\mu$ sec   | 50 $\mu$ SEC/CM     | 5                  |
| 5    | 100 $\mu$ sec   | 100 $\mu$ SEC/CM    | 10                 |
| 6    | 100 $\mu$ sec   | 200 $\mu$ SEC/CM    | 20                 |
| 7    | 1 ms            | .5 MILLISECONDS/CM  | 5                  |
| 8    | 1 ms            | 1 MILLISECONDS/CM   | 10                 |
| 9    | 1 ms            | 2 MILLISECONDS/CM   | 20                 |
| 10   | 10 ms           | 5 MILLISECONDS/CM   | 5                  |
| 11   | 10 ms           | 10 MILLISECONDS/CM  | 10                 |
| 12   | 10 ms           | 20 MILLISECONDS/CM  | 20                 |
| 13   | 100 ms          | 50 MILLISECONDS/CM  | 5                  |
| 14   | 100 ms          | 100 MILLISECONDS/CM | 10                 |
| 15   | 100 ms          | 200 MILLISECONDS/CM | 20                 |

\*  $\pm 0.5$  cm

5-66. LINE-VOLTAGE VARIATION CHECK. Check line-voltage variation as follows:

a. Connect power cable to power autotransformer and adjust output to 115 volts ac.

b. Set VERTICAL SENSITIVITY to CAL.

c. Set HORIZONTAL DISPLAY to 2 MILLISECONDS/CM.

d. Set TRIGGER LEVEL to AUTO.

e. Adjust horizontal VERNIER to obtain exactly 5 cycles of calibrator signal per 10 cm; note exact amplitude of each calibrator signal.

f. Set line voltage to 103 volts ac, then to 127 volts ac. (Allow periods of at least 2 minutes for each voltage.) Calibrator signal amplitude should be  $\pm 0.3$  cm; the five cycles of the signal should change less than 0.5 cm in length.

## 5-67. DIAGRAMS.

5-68. Figures 5-6 through 5-11 are schematic diagrams of the Model 120B. DC voltages are provided on the schematics as an aid in troubleshooting.

5-69. The following notations are applicable to figures 5-6 through 5-11.

a. All values are in ohms, picofarads, and microhenries unless otherwise indicated.

b. Lettering enclosed in heavy boxes indicates front-panel engraving.

c. Voltage measurements are with respect to ground and made with Hewlett-Packard Model 412A VTVM.

d. Voltage measurements are made with Model 120B front-panel controls set as follows:

| Control                     | Setting        |
|-----------------------------|----------------|
| VERTICAL SENSITIVITY switch | CAL            |
| VERTICAL VERNIER control    | CAL            |
| Vertical AC-DC switch       | AC             |
| FOCUS control               | Centered       |
| VERTICAL POSITION control   | Centered       |
| INTENSITY control           | Centered       |
| HORIZONTAL POSITION control | Centered       |
| HORIZONTAL DISPLAY switch   | 5 $\mu$ SEC/CM |
| HORIZONTAL VERNIER control  | CAL            |
| TRIGGER SOURCE switch       | INT-           |
| TRIGGER LEVEL control       | AUTO           |
| Horizontal AC-DC switch     | AC             |
| SWEEP MAGNIFIER switch      | X1             |

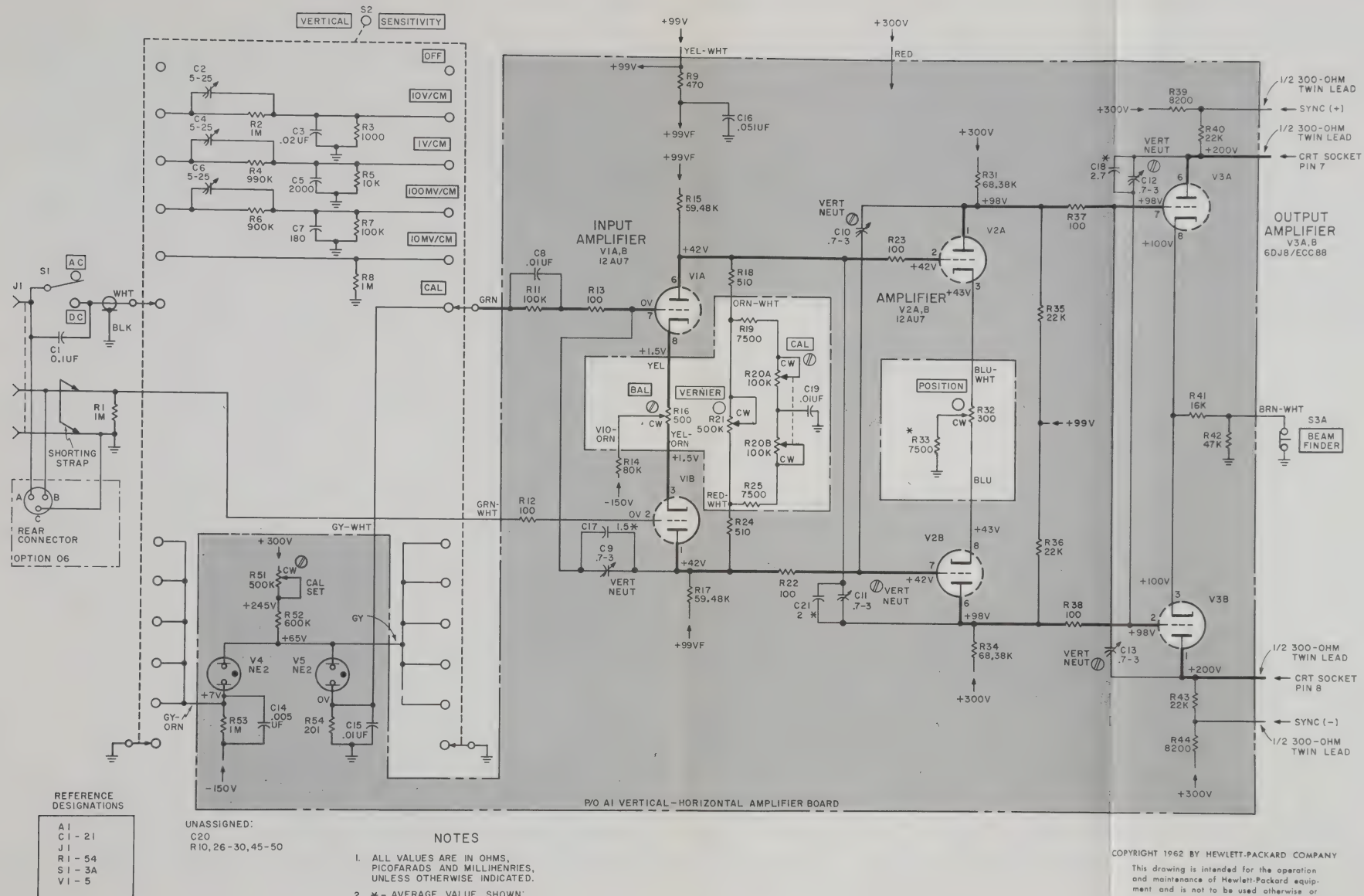


Figure 5-6. Vertical Amplifier



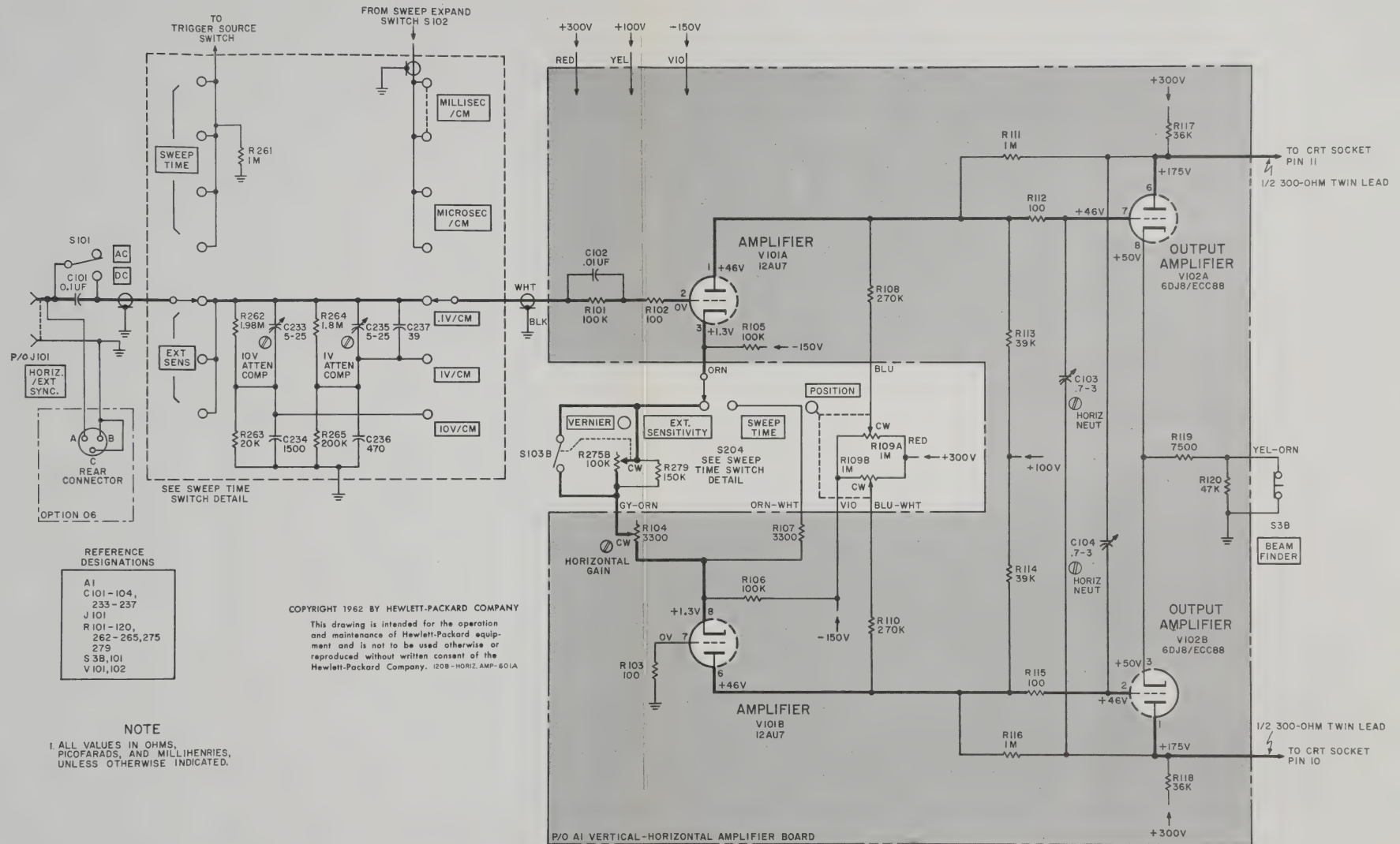
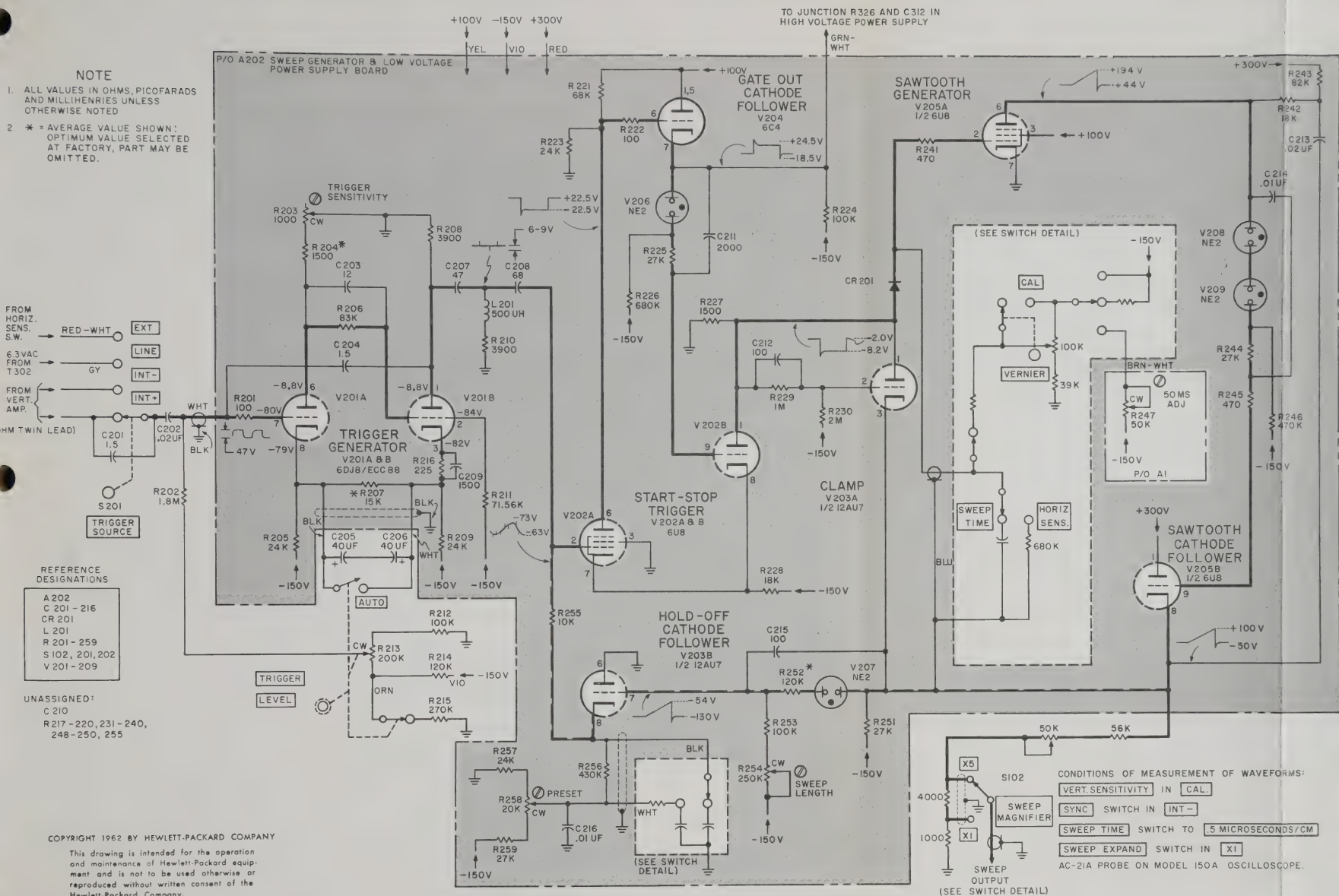
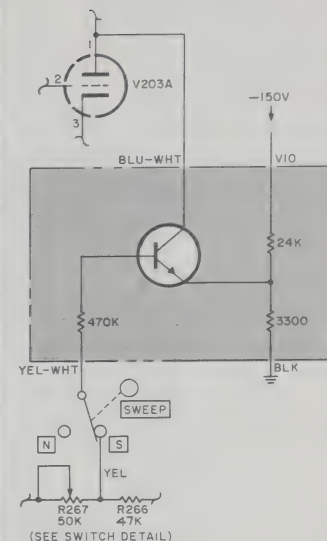
Section V  
Figure 5-7

Figure 5-7. Horizontal Amplifier

## NOTE

- ALL VALUES IN OHMS, PICO FARADS AND MILLIHENRIES UNLESS OTHERWISE NOTED
- \* AVERAGE VALUE SHOWN; OPTIMUM VALUE SELECTED AT FACTORY, PART MAY BE OMITTED.

SINGLE SWEEP OPERATION  
(OPTION 10)

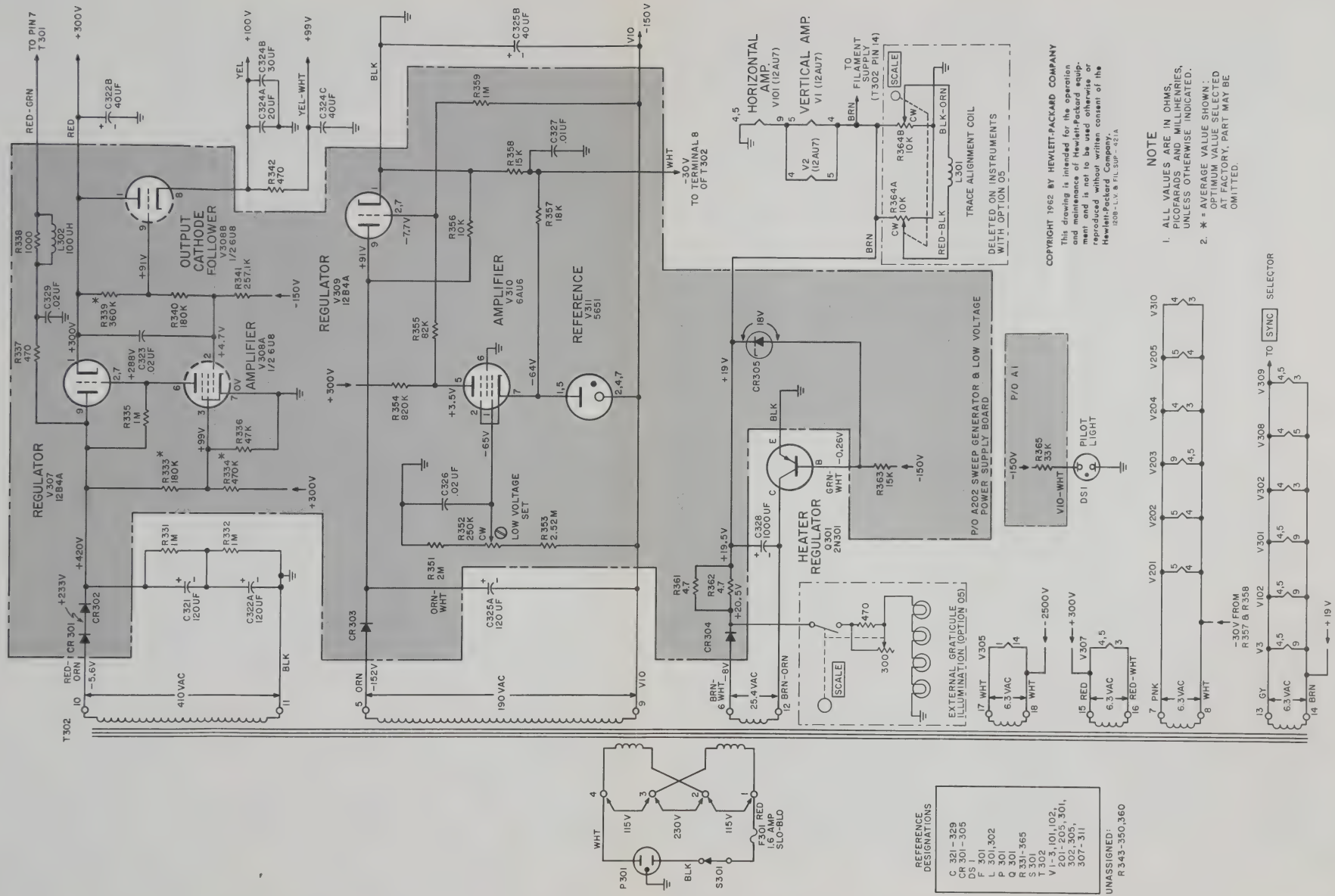


Figure 5-9. Low-Voltage Power Supply



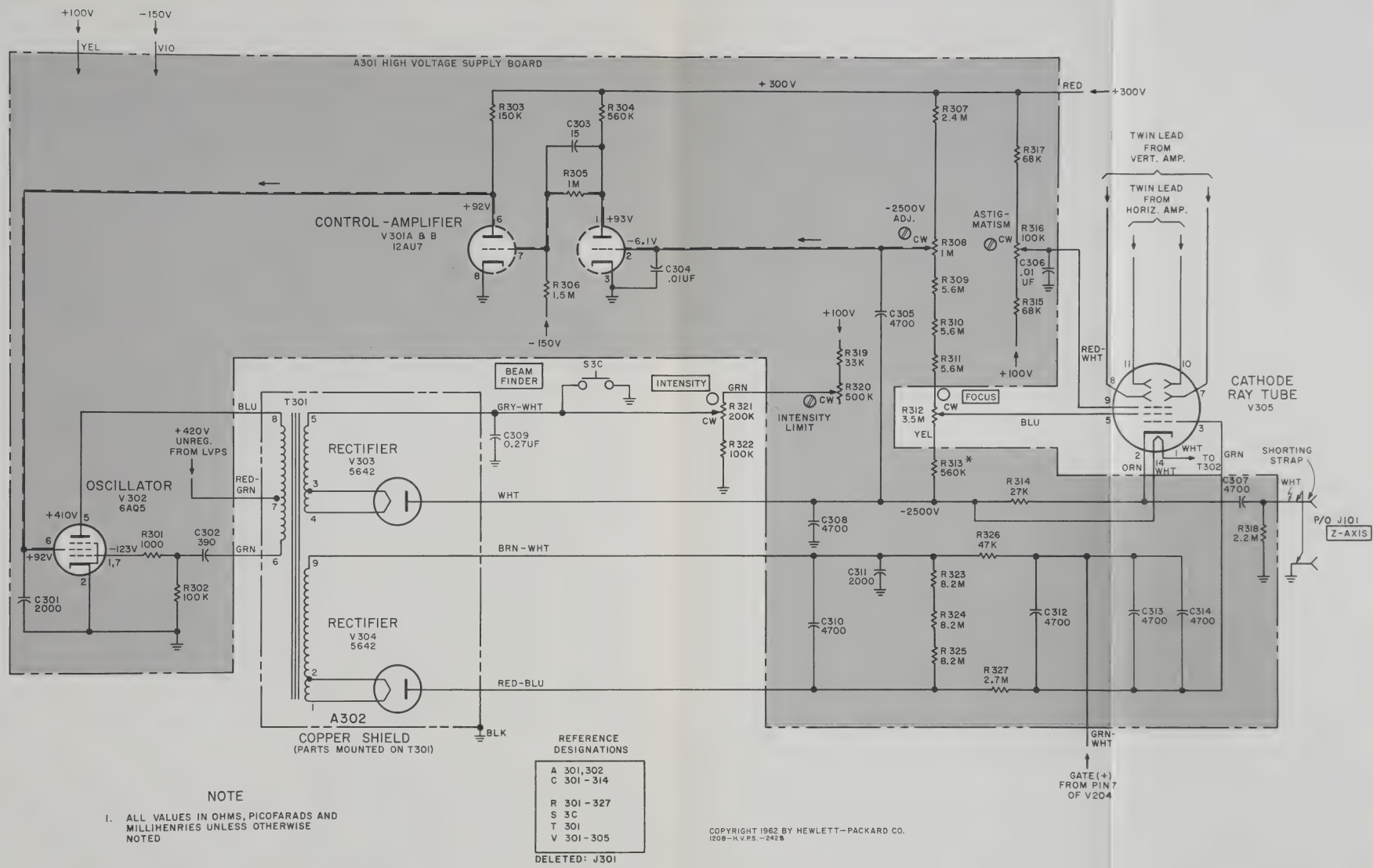


Figure 5-10. High-Voltage Power Supply

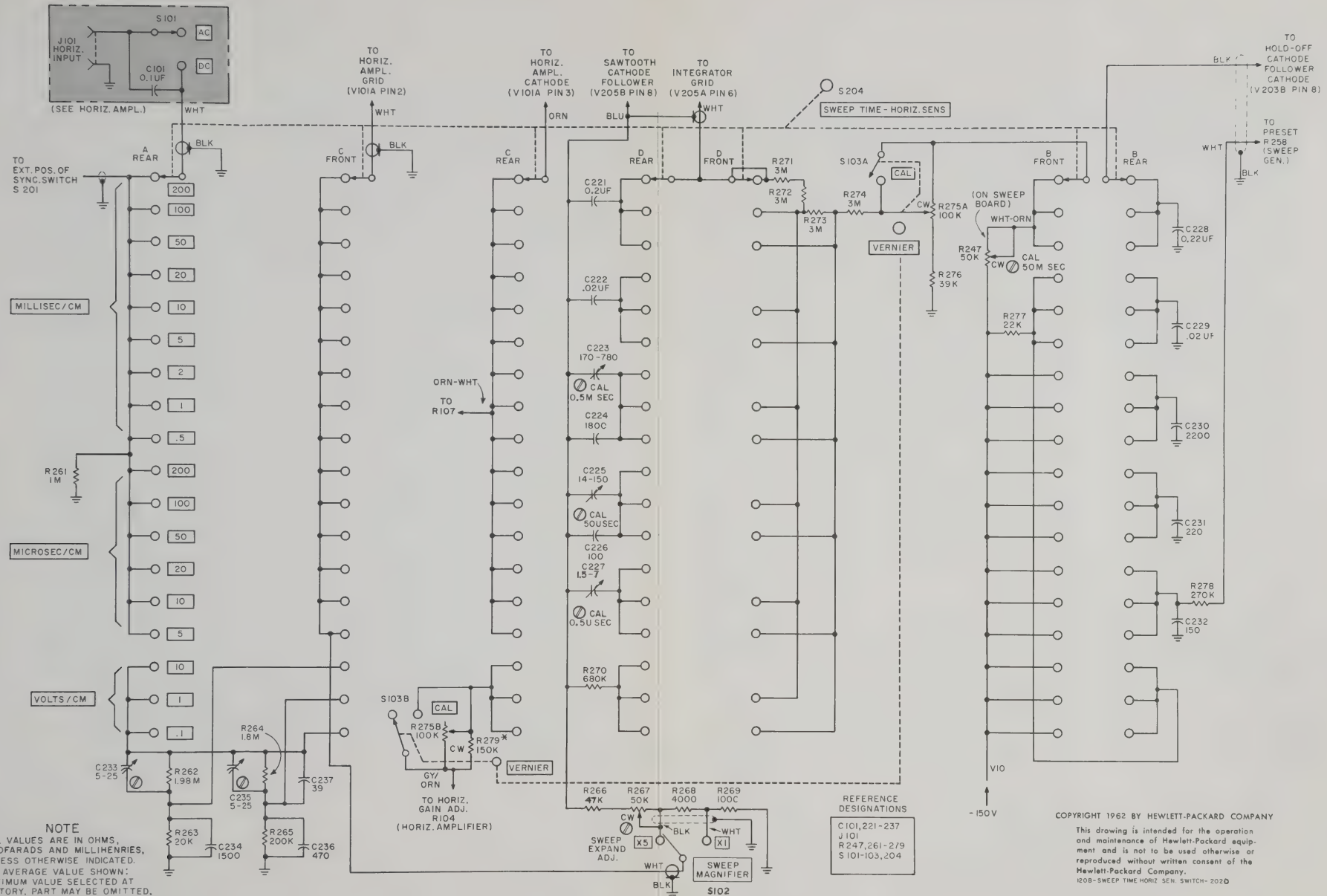


Figure 5-11. Horizontal Display Switch

## SECTION VI

### REPLACEABLE PARTS

#### 6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the Model 120B. Table 6-1 lists reference designators and abbreviations that are used in the Table 6-2 component descriptions. Table 6-2 lists the parts in alpha-numerical order of their reference designations and provides the following information for each item:

- a. The hp part number.
- b. Total quantity (TQ) used in the instrument; given only first time the part number is listed.
- c. Description of part (refer to Table 6-1).
- d. Typical manufacturer of the part in a five-digit code, except for Hewlett-Packard Company; see code list of manufacturers, Table 6-3, for name.
- e. Manufacturer's part number.

6-3. Parts not identified by a reference designation are listed at the end of Table 6-2, under miscellaneous. Cabinet parts and the rack mounting kit for the instrument are illustrated and listed in Figure 6-1.

#### 6-4. ORDERING INFORMATION.

6-5. To order replacement parts from the Hewlett-Packard Company, address the order or inquiry to the nearest hp Sales/Service Office (see list of address at rear of this manual) and supply the following information:

- a. The hp part number of item(s).
  - b. Model number and eight-digit serial number of the instrument.
- 6-6. To order a part not listed in Table 6-2, provide the following information.
- a. Model number and eight digit serial number of the instrument.
  - b. Description of part including function and location.

6-7. To order a part from a manufacturer other than the Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from Table 6-2.

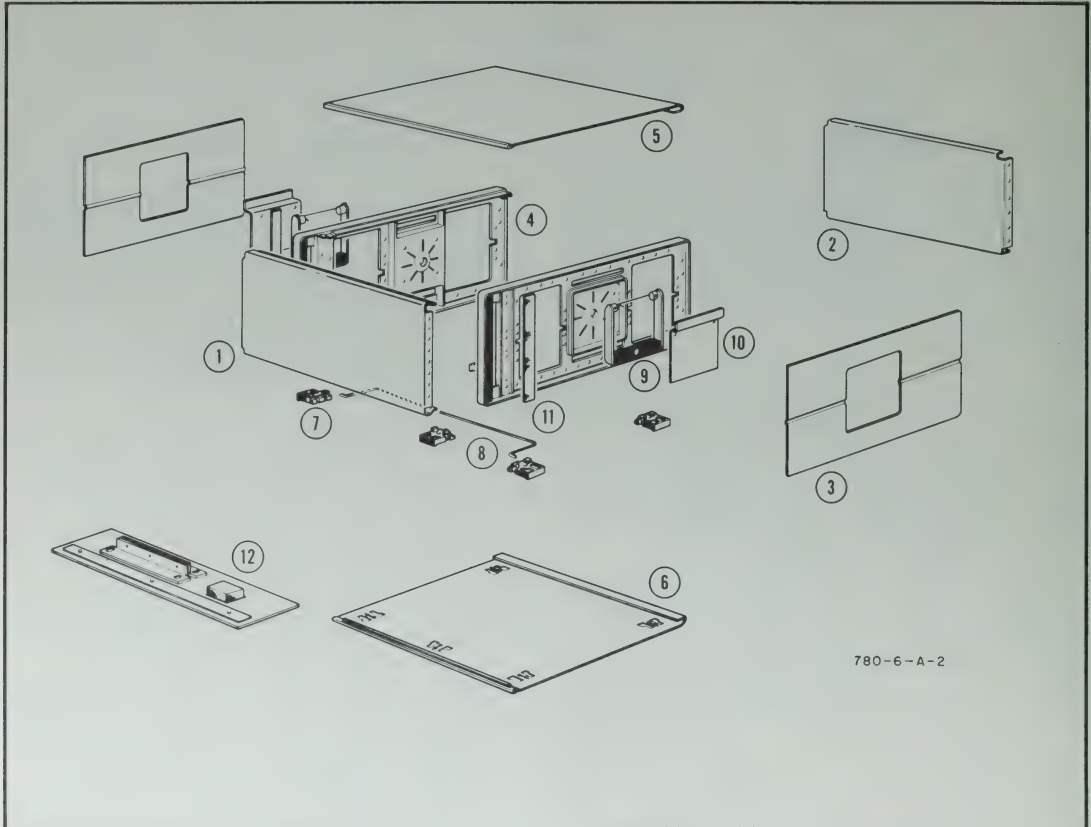
Table 6-1. List of Reference Designators and Abbreviations

| REFERENCE DESIGNATORS                |                              |   |   |
|--------------------------------------|------------------------------|---|---|
| A = assembly                         | E = misc electronic part     | MP = mechanical part  | TB = terminal board                         |
| B = motor                            | F = fuse                     | P = plug  | TP = test point                             |
| C = capacitor                        | FL = filter                  | Q = transistor  | V = vacuum tube, neon bulb, photocell, etc. |
| CP = coupling                        | J = jack                     | R = resistor  | W = cable                                   |
| CR = diode                           | K = relay                    | RT = thermistor   | X = socket                                  |
| DL = delay line                      | L = inductor                 | S = switch  | Y = crystal                                 |
| DS = device signaling (lamp)         | M = meter                    | T = transformer   |   |
| ABBREVIATIONS                        |                              |   |   |
| A = amperes                          | GE = germanium               | N/C = normally closed                                       | RMO = rack mount only                       |
| A.F.C = automatic frequency control  | GL = glass                   | NE = neon   | RMS = root-mean-square                      |
| AMPL = amplifier                     | GRD = ground(ed)             | NI PL = nickel plate  |   |
|                                      |                              | N/O = normally open   | S-B = slow-blow                             |
| B. F. O. = beat frequency oscillator | H = henries                  | NPO = negative positive zero (zero temperature coefficient) | SCR = screw                                 |
| BE CU = beryllium copper             | HEX = hexagonal              | NRFR = not recommended for field replacement                | SE = selenium                               |
| BH = binder head                     | HG = mercury                 | NSR = not separately replaceable                            | SECT = section(s)                           |
| BP = bandpass                        | HR = hour(s)                 |   | SEMICON = semiconductor                     |
| BRS = brass                          | hp = Hewlett-Packard         |   | SI = silicon                                |
| BWO = backward wave oscillator       | IF = intermediate freq       |   | SIL = silver                                |
|                                      | IMPG = impregnated           |   | SL = slide                                  |
| CCW = counter-clockwise              | INCD = incandescent          |   | SPL = special                               |
| CER = ceramic                        | INCL = include(s)            | OBD = order by description                                  | SST = stainless steel                       |
| CMO = cabinet mount only             | INS = insulation(ed)         | OH = oval head  | SR = split ring                             |
| COEF = coefficient                   | INT = internal               | OX = oxide  | STL = steel                                 |
| COM = common                         |                              |   |   |
| COMP = composition                   | K = kilo = 1000              | P = peak  | TA = tantalum                               |
| CONN = connector                     |                              | PC = printed circuit  | TD = time delay                             |
| CP = cadmium plate                   | LIN = linear taper           | PF = picofarads = 10 <sup>-12</sup> farads                  | TGL = toggle                                |
| CRT = cathode-ray tube               | LK WASH = lock washer        | PH BRZ = phosphor bronze                                    | TI = titanium                               |
| CW = clockwise                       | LOG = logarithmic taper      | PHL = Phillips  | TOL = tolerance                             |
|                                      | LPF = low pass filter        | PIV = peak inverse voltage                                  | TRIM = trimmer                              |
| DEPC = deposited carbon              |                              | P/O = part of   | TWT = traveling wave tube                   |
| DR = drive                           |                              | POLY = polystyrene  |   |
|                                      |                              | PORC = porcelain  | U = micro = 10 <sup>-6</sup>                |
| ELECT = electrolytic                 | M = milli = 10 <sup>-3</sup> | POS = position(s)   | VAR = variable                              |
| ENCAP = encapsulated                 | MEG = meg = 10 <sup>6</sup>  | POT = potentiometer   | VDCW = dc working volts                     |
| EXT = external                       | METFLM = metal film          | PP = peak-to-peak   |   |
|                                      | MFR = manufacturer           | PT = point  | W/ = with                                   |
| F = farads                           | MINAT = miniature            | RECT = rectifier  | W = watts                                   |
| FH = flat head                       | MOM = momentary              | RF = radio frequency  | WW = wirewound                              |
| FIL H = fillister head               | MTG = mounting               | RH = round head   | W/O = without                               |
| FXD = fixed                          | MY = "mylar"                 |   |   |
|                                      | N = nano (10 <sup>-9</sup> ) |   |   |

01194-10

01260-3





780-6-A-2

| Index No. | hp Part No. | Description               | TQ |
|-----------|-------------|---------------------------|----|
| 1         | 120B-2D     | Panel: front              | 1  |
| 2         | 120B-2C     | Panel: rear               | 1  |
| 3         | 5000-0743   | Cover: side               | 2  |
| 4         | 5060-0734   | Casting: frame side       | 2  |
| 5         | 120B-44A-1  | Cover: top                | 1  |
| 6         | 5060-0758   | Cover: bottom             | 1  |
| 7         | 5060-0767   | Foot: plastic             | 5  |
| 8         | 1490-0030   | Stand: tilt               | 1  |
| 9         | 5060-0763   | Handle: side              | 2  |
| 10        | 5060-0765   | Retainer: handle          | 2  |
| 11        | 5000-0052   | Plate: trim adhesive back | 2  |
| 12        | 5060-0776   | Kit: rack mount           | 1  |

Figure 6-1. Modular Cabinet Replaceable Parts

Table 6-2. Replaceable Parts

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)            | Mfr   | Mfr Part No.    |
|--------------|-------------|----|----|--|-------|-----------------|
| A1           | 120B-65F    | 1  |    | A: pc vert and horiz amplifiers            | hp    |                 |
| A2           | 120B-19A    | 1  |    | A: switch vertical                         | hp    |                 |
| A3           | 120B-12E    | 2  |    | A: ac-dc switch (incl bracket and S1)      | hp    |                 |
| A101         | 120B-6C     | 1  |    | A: vert shield (incl bracket and S102)     | hp    |                 |
| A102         | 120B-12E    |    |    | A: ac-dc switch (incl bracket and S101)    | hp    |                 |
| A201         | 120B-19D    | 1  |    | A: switch trigger source                   | hp    |                 |
| A202         | 120B-65G    | 1  |    | A: pc sweep and lv supply                  | hp    |                 |
| A204         | 120B-19B    | 1  |    | A: switch horiz                            | hp    |                 |
| A301         | 120B-65E    | 1  |    | A: pc hv supply                            | hp    |                 |
| A302         | 120B-11B    | 1  |    | A: rectifier (incl T301, C309, V303, V304) | hp    |                 |
| C1           | 0170-0022   | 2  |    | C: fxd my 0.1 $\mu$ f 20% 600vdcw          | 84411 | HEW 7           |
| C2           | 0130-0014   | 3  |    | C: var cer 5-25 pf 500vdcw                 | 72982 | 577-030-COP-39R |
| C3           | 0170-0027   | 3  |    | C: fxd my 0.02 $\mu$ f 5% 200vdcw          | 84411 | 600UE20352      |
| C4           | 0130-0014   |    |    | C: var cer 5-25 pf 500vdcw                 | 72982 | 577-030-COP-39R |
| C5           | 0160-2566   | 1  |    | C: fxd mica 2000 pf 2% 300vdcw             | hp    |                 |
| C6           | 0130-0014   |    |    | C: var cer 5-25 pf 500vdcw                 | 72982 | 577-030-COP-39R |
| C7           | 0140-0147   | 1  |    | C: fxd mica 180 pf 5% 500vdcw              | 72136 | DM15F181J       |
| C8           | 0150-0012   | 9  |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw        | 71590 | 13C DISC        |
| C9           | 0132-0004   | 6  |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-009-4R      |
| C10          | 0132-0004   |    |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-009-4R      |
| C11          | 0132-0004   |    |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-009-4R      |
| C12          | 0132-0004   |    |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-009-4R      |
| C13          | 0132-0004   |    |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-009-4R      |
| C14          | 0150-0014   | 1  |    | C: fxd cer 0.005 $\mu$ f 500vdcw           | 04222 | D1-4            |
| C15          | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw        | 71550 | 13C DISC        |
| C16          | 0170-0003   | 1  |    | C: fxd my 0.051 $\mu$ f 10% 200vdcw        | 00853 | 33M02151        |
| C17          | 0150-0011   | 3  |    | C: fxd ti-ox 1.5 pf 20% 500vdcw            | 78488 | TYPE GA OBD     |
| C18          | 0150-0041   | 1  |    | C: fxd ti-ox 2.7 pf 5% 500vdcw             | 78488 | TYPE GA OBD     |
| C19          | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw        | 71590 | 13C DISC        |
| C21          | 0150-0031   | 1  |    | C: fxd ti-ox 2 pf 5% 500vdcw               | 78488 | TYPE GA OBD     |
| C101         | 0170-0022   |    |    | C: fxd my 0.1 $\mu$ f 20% 600vdcw          | 84411 | HEW 7           |
| C102         | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw        | 71590 | 13C DISC        |
| C103         | 0132-0004   |    |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-009-4R      |
| C104         | 0132-0002   | 1  |    | C: var poly 0.7-3 pf 350vdcw               | 72982 | 535-015-4R      |
| C201         | 0150-0011   |    |    | C: fxd ti-ox 1.5 pf 20% 500vdcw            | 78488 | TYPE GA OBD     |
| C202         | 0150-0024   | 5  |    | C: fxd cer 0.02 $\mu$ f -20%+80% 600vdcw   | 91418 | BO.02 GMV       |
| C203         | 0140-0201   | 1  |    | C: fxd mica 12 pf 5% 500vdcw               | 72136 | DM15C120J       |
| C204         | 0150-0011   |    |    | C: fxd ti-ox 1.5 pf 20% 500vdcw            | 78488 | TYPE GA OBD     |
| C205         | 0180-0050   | 2  |    | C: fxd elect 40 $\mu$ f -15%+100% 500vdcw  | 56289 | D 32538         |

Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)                       | Mfr   | Mfr Part No.    |
|--------------|-------------|----|----|---|-------|-----------------|
| C206         | 0180-0050   |    |    | C: fxd elect 40 $\mu$ f -15%+100% 500vdcw             | 56289 | D 32538         |
| C207         | 0140-0039   | 1  |    | C: fxd mica 47 pf 5% 500vdcw                          | 76433 | RCM15E470J      |
| C208         | 0140-0082   | 1  |    | C: fxd mica 68 pf 5% 500vdcw                          | 76433 | RCM15E680J      |
| C209         | 0140-0156   | 2  |    | C: fxd mica 1500 pf 2% 300vdcw                        | 72136 | DM19F152G       |
| C211         | 0150-0023   | 3  |    | C: fxd cer 2000 pf 20% 1000vdcw                       | 91418 | JFO.002-20%     |
| C212         | 0140-0041   | 3  |    | C: fxd mica 100 pf 5% 500vdcw                         | 76433 | RCM15E101J      |
| C213         | 0150-0024   |    |    | C: fxd cer .02 $\mu$ f -20%+80% 600vdcw               | 91418 | BO.02 GMV       |
| C214         | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw                   | 71590 | 13C DISC        |
| C215         | 0140-0041   |    |    | C: fxd mica 100 pf 5% 500vdcw                         | 78488 | TYPE GA OBD     |
| C216         | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw                   | 71590 | 13C DISC        |
| C221         | 0170-0028   | 1  |    | C: fxd my 0.2 $\mu$ f 50% 200vdcw                     | 84411 | 600UE20452      |
| C222         | 0170-0027   |    |    | C: fxd my 0.02 $\mu$ f 5% 200vdcw                     | 84411 | 600UE20352      |
| C223         | 0131-0003   | 1  |    | C: var mica 170-780 pf 175vdcw                        | 72136 | T52910          |
| C224         | 0170-0026   | 1  |    | C: fxd my 1800 pf 5% 200vdcw                          | 84411 | 60QUE18252      |
| C225         | 0131-0004   | 1  |    | C: var mica 14-150 pf 175vdcw                         | 72136 | T51410-3        |
| C226         | 0140-0041   |    |    | C: fxd mica 100 pf 5% 500vdcw                         | 76433 | RCM15E101J      |
| C227         | 0130-0003   | 1  |    | C: var cer 1.5-7 pf NPO 500vdcw                       | hp    |                 |
| C228         | 0160-0380   | 1  |    | C: fxd my 0.22 $\mu$ f 10% 200vdcw                    | hp    |                 |
| C229         | 0170-0027   |    |    | C: fxd my 0.02 $\mu$ f 5% 200vdcw                     | 84411 | 600UE20352      |
| C230         | 0160-0007   | 1  |    | C: fxd my 2200 pf 10% 600vdcw                         | 56289 | 160P22296       |
| C231         | 0140-0031   | 1  |    | C: fxd mica 220 pf 10% 500vdcw                        | 76433 | RCM20B221K      |
| C232         | 0140-0055   | 1  |    | C: fxd mica 150 pf 10% 500vdcw                        | 76433 | RCM20B151K      |
| C233         | 0130-0016   | 2  |    | C: var cer 5-25 pf 500vdcw                            | 72982 | 557-019-COP-39R |
| C234         | 0140-0156   |    |    | C: fxd mica 1500 pf 2% 300vdcw                        | 72136 | DM19F152G       |
| C235         | 0130-0016   |    |    | C: var cer 5-25 pf 500vdcw                            | 72985 | 557-019-COP-39R |
| C236         | 0140-0027   | 1  |    | C: fxd mica 470 pf 10% 500vdcw                        | 76433 | RCM20B471K      |
| C237         | 0140-0035   | 1  |    | C: fxd mica 39 pf 5% 500vdcw                          | 76433 | RCM15E390J      |
| C301         | 0150-0023   |    |    | C: fxd cer 2000 pf 20% 1000vdcw                       | 91418 | JFO.002-20%     |
| C302         | 0140-0037   | 1  |    | C: fxd mica 390 pf 5% 500vdcw                         | 76433 | RCM15E391J      |
| C303         | 0140-0004   | 1  |    | C: fxd mica 15 pf 10% 500vdcw                         | 72982 | 535-009-4R      |
| C304         | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw                   | 71590 | 13C DISC        |
| C305         | 0160-0151   | 7  |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C306         | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw                   | 71590 | 13C DISC        |
| C307         | 0160-0151   |    |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C308         | 0160-0151   |    |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C309         | 0160-0039   | 1  |    | C: fxd my 0.27 $\mu$ f 10% 200vdcw                    | 56289 | 160P27492       |
| C310         | 0160-0151   |    |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C311         | 0150-0023   |    |    | C: fxd cer 2000 pf 20% 1000vdcw                       | 91418 | JFO.002-20%     |
| C312         | 0160-0151   |    |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C313         | 0160-0151   |    |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C314         | 0160-0151   |    |    | C: fxd cer 4700 pf -20%+80% 4000vdcw                  | 71590 | DA172-097CB     |
| C321         | 0180-0126   | 1  |    | C: fxd elect 120 $\mu$ f 300vdcw                      | 56289 | D36236          |
| C322A/B      | 0180-0030   | 1  |    | C: fxd elect 2 sect 120 - 40 $\mu$ f 450vdcw          | 56289 | D32352          |
| C323         | 0150-0024   |    |    | C: fxd cer .02 $\mu$ f -20%+80% 600vdcw               | 91418 | BO.02 GMV       |
| C324A/B/C    | 0180-0053   | 1  |    | C: fxd elect 3 sect 40-30-20 $\mu$ f 150vdcw          | 56289 | OBD             |
| C325A/B      | 0180-0127   | 1  |    | C: fxd elect 2 sect 120 - 40 $\mu$ f -10%+50% 300vdcw | 56289 | D36235          |
| C326         | 0150-0024   |    |    | C: fxd cer .02 $\mu$ f -20%+80% 600vdcw               | 91418 | BO.02 GMV       |
| C327         | 0150-0012   |    |    | C: fxd cer .01 $\mu$ f 20% 1000vdcw                   | 71590 | 13C DISC        |
| C328         | 0180-0056   | 1  |    | C: fxd elect 1000 $\mu$ f 50vdcw                      | 56289 | D32429          |
| C329         | 0150-0024   |    |    | C: fxd cer .02 $\mu$ f -20%+80% 600vdcw               | 91418 | BO.02 GMV       |



Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)                | Mfr   | Mfr Part No. |
|--------------|-------------|----|----|--|-------|--------------|
| CR201        | 1901-0044   | 1  |    | CR: si   | hp    |              |
| CR301        | 1901-0030   | 3  |    | CR: si   | 02735 | OBD          |
| CR302        | 1901-0030   |    |    | CR: si   | 02735 | OBD          |
| CR303        | 1901-0030   |    |    | CR: si   | 02735 | OBD          |
| CR304        | 1901-0045   | 1  |    | CR: si   | hp    |              |
| CR305        | 1902-0225   | 1  |    | CR: si breakdown 18.7v                         | hp    |              |
| DS1          | 1450-0048   | 1  |    | DS: neon indicator                             | 08717 | 858-R        |
| F301         | 2110-0005   | 1  |    | F: cartridge 1.6 amp s-b (for 115 v operation) | 71400 | MDL1.6       |
|              | 2110-0020   |    |    | F: cartridge 0.8 amp s-b (for 230 v operation) | 71400 | OBD          |
| J1           |             |    |    | NSR - consists of:                             |       |              |
|              | 5060-0633   | 4  |    | Binding Post: red (2 required)                 | hp    |              |
|              | 5060-0625   | 1  |    | Binding Post: black                            | hp    |              |
|              | 0340-0091   | 2  |    | Insulator: 3 hole                              | hp    |              |
|              | 0340-0086   | 1  |    | Insulator: 2 hole                              | hp    |              |
| J101         |             |    |    | NSR - consists of:                             |       |              |
|              | 5060-0633   |    |    | Binding Post: red (2 required)                 | hp    |              |
|              | 5060-0626   | 1  |    | Binding Post: black                            | hp    |              |
|              | 0340-0091   |    |    | Insulator: 3 hole                              | hp    |              |
|              | 0340-0087   | 1  |    | Insulator: 3 hole                              | hp    |              |
| L201         | 9140-0022   | 1  |    | L: fxd rf 500 $\mu$ h 10%                      | 99848 | 1500-15-501  |
| L301         | 5060-0409   | 1  |    | L: coil (trace align)                          | hp    |              |
| L302         | 9140-0029   | 1  |    | L: fxd rf 100 $\mu$ h                          | 99848 | 3100-15-101  |
| P301         |             |    |    | NSR: part of power cordW1                      |       |              |
| Q301         | 1850-0038   | 1  |    | Q: ge pnp                                      | hp    |              |
| R1           | 0686-1055   | 4  |    | R: fxd comp 1 megohm 5% 1/2w                   | 01121 | EB1055       |
| R2           | 0757-0059   | 3  |    | R: fxd metfilm 1 megohm 1% 1/2w                | hp    |              |
| R3           | 0757-0159   | 1  |    | R: fxd metfilm 1000 ohms 1% 1/2w               | hp    |              |
| R4           | 0757-0057   | 1  |    | R: fxd metfilm 990 ohms 1% 1/2w                | hp    |              |
| R5           | 0757-0839   | 1  |    | R: fxd metfilm 10k ohms 1% 1/2w                | hp    |              |
| R6           | 0757-0054   | 1  |    | R: fxd metfilm 900k ohms 1% 1/2w               | hp    |              |
| R7           | 0757-0367   | 1  |    | R: fxd metfilm 100k ohms 1% 1/2w               | hp    |              |
| R8           | 0686-1055   |    |    | R: fxd comp 1 megohm 5% 1/2w                   | 01121 | EB1055       |
| R9           | 0687-4711   | 5  |    | R: fxd comp 470 ohms 10% 1/2w                  | 01121 | EB4711       |
| R11          | 0687-1041   | 6  |    | R: fxd comp 100k ohms 10% 1/2w                 | 01121 | EB1041       |
| R12          | 0687-1011   | 12 |    | R: fxd comp 100 ohms 10% 1/2w                  | 01121 | EB1011       |
| R13          | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                  | 01121 | EB1011       |
| R14          | 0730-0062   | 1  |    | R: fxd depc 80k ohms 1% 1w                     | hp    |              |
| R15          | 0727-0197   | 2  |    | R: fxd depc 59.48k ohms 1% 1/2w                | hp    |              |

Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)                                    | Mfr   | Mfr Part No.   |
|--------------|-------------|----|----|--|-------|----------------|
| R16          | 2100-0054   | 1  |    | R: var ww 500 ohms 10% 2w  | 11237 | 252 OBD        |
| R17          | 0727-0197   |    |    | R: fxd depc 59.48k ohms 1% 1/2w                                    | hp    |                |
| R18          | 0758-0030   | 2  |    | R: fxd met ox 510 ohms 5% 1/2w                                     | hp    |                |
| R19          | 0758-0047   | 3  |    | R: fxd met ox 7500 ohms 5% 1/2w                                    | hp    |                |
| R20A/B       | 2100-0339   | 1  |    | R: var comp log dual 100k ohms 20% 1/4w                            | 11237 | OBD            |
| R21          | 2100-0174   | 1  |    | R: var comp 500k ohms 20% , 5% cw log taper, 1/4w<br>w/spdt switch | 11237 | RGC-45         |
| R22          | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R23          | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R24          | 0758-0030   |    |    | R: fxd met ox 510 ohms 5% 1/2w                                     | hp    |                |
| R25          | 0758-0047   |    |    | R: fxd met ox 7500 ohms 5% 1/2w                                    | hp    |                |
| R31          | 0730-0056   | 2  |    | R: fxd depc 68.38k ohms 1% 1w                                      | hp    |                |
| R32          | 2100-1486   | 1  |    | R: var comp 300 ohms 20% 3w  | hp    |                |
| R33          | 0730-0024   | 1  |    | R: fxd depc 7500 ohms 1% 1w  | hp    |                |
| R34          | 0730-0056   |    |    | R: fxd depc 68.38k ohms 1% 1w                                      | hp    |                |
| R35          | 0687-2231   | 3  |    | R: fxd comp 22k ohms 10% 1/2w                                      | 01121 | EB2231         |
| R36          | 0687-2231   |    |    | R: fxd comp 22k ohms 10% 1/2w                                      | 01121 | EB2231         |
| R37          | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R38          | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R39          | 0690-8221   | 2  |    | R: fxd comp 8200 ohms 10% 1w                                       | 01121 | GB8221         |
| R40          | 0758-0020   | 2  |    | R: fxd met ox 22k ohms 5% 1/2w                                     | hp    |                |
| R41          | 0689-1635   | 1  |    | R: fxd comp 16k ohms 5% 1w   | 01121 | GB1635         |
| R42          | 0687-4731   | 5  |    | R: fxd comp 47k ohms 10% 1/2w                                      | 01121 | EB4731         |
| R43          | 0758-0020   |    |    | R: fxd met ox 22k ohms 5% 1/2w                                     | hp    |                |
| R44          | 0690-8221   |    |    | R: fxd comp 8200 ohms 10% 1w                                       | 01121 | GB8221         |
| R51          | 2100-0102   | 2  |    | R: var comp 500k ohms 30% 0.1w                                     | 11237 | UPE 70 SPECIAL |
| R52          | 0727-0246   | 1  |    | R: fxd depc 600k ohms 1% 1/2w                                      | hp    |                |
| R53          | 0686-1055   |    |    | R: fxd comp 1 megohm 5% 1/2w                                       | 01121 | EB1055         |
| R54          | 0727-0055   | 1  |    | R: fxd depc 201 ohms 1% 1/2w                                       | hp    |                |
| R101         | 0687-1041   |    |    | R: fxd comp 100k ohms 10% 1/2w                                     | 01121 | EB1041         |
| R102         | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R103         | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R104         | 2100-0182   | 1  |    | R: var comp 3300 ohms 10% 1/3w                                     | 11237 | UPE 70         |
| R105         | 0690-1041   | 3  |    | R: fxd comp 100k ohms 10% 1w                                       | 01121 | GB1041         |
| R106         | 0690-1041   |    |    | R: fxd comp 100k ohms 10% 1w                                       | 01121 | GB1041         |
| R107         | 0687-3321   | 1  |    | R: fxd comp 3300 ohms 10% 1/2w                                     | 01121 | EB3321         |
| R108         | 0687-2741   | 3  |    | R: fxd comp 270k ohms 10% 1/2w                                     | 01121 | EB2741         |
| R109A/B      | 2100-0258   | 1  |    | R: var comp dual 1 megohm 20% 1/4w                                 | 11237 | 2-45           |
| R110         | 0687-2741   |    |    | R: fxd comp 270k ohms 10% 1/2w                                     | 01121 | EB2741         |
| R111         | 0757-0059   |    |    | R: fxd metflm 1 megohm 1% 1/2w                                     | hp    |                |
| R112         | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R113         | 0757-0050   | 2  |    | R: fxd met ox 39k ohms 5% 1/2w                                     | hp    |                |
| R114         | 0758-0050   |    |    | R: fxd met ox 39k ohms 5% 1/2w                                     | hp    |                |
| R115         | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w                                      | 01121 | EB1011         |
| R116         | 0757-0059   |    |    | R: fxd metflm 1 megohm 1% 1/2w                                     | hp    |                |

Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)  | Mfr   | Mfr Part No.   |
|--------------|-------------|----|----|----------------------------------|-------|----------------|
| R117         | 0692-3635   | 2  |    | R: fxd comp 36k ohms 5% 2w       | 01121 | HB3635         |
| R118         | 0692-3635   |    |    | R: fxd comp 36k ohms 5% 2w       | 01121 | HB3635         |
| R119         | 0758-0047   |    |    | R: fxd met ox 7500 ohms 5% 1/2w  | hp    |                |
| R120         | 0687-4731   |    |    | R: fxd comp 47k ohms 10% 1/2w    | 01121 | EB4731         |
| R201         | 0687-1011   | 1  |    | R: fxd comp 100 ohms 10% 1/2w    | 01121 | EB1011         |
| R202         | 0687-1851   |    |    | R: fxd comp 1.8 megohms 10% 1/2w | 01121 | EB1851         |
| R203         | 2100-0154   |    | 1  | R: var comp 1000 ohms 30% 0.1w   | 11237 | UPE 70         |
| R204         | 0758-0017   |    | 1  | R: fxd met ox 1500 ohms 5% 1/2w  | hp    |                |
| R205         | 0758-0073   |    | 4  | R: fxd met ox 24k ohms 5% 1/2w   | hp    |                |
| R206         | 0727-0202   | 1  |    | R: fxd depc 83k ohms 1% 1/2w     | hp    |                |
| R207         | 0687-1531   | 2  |    | R: fxd comp 15k ohms 10% 1/2w    | 01121 | EB1531         |
| R208         | 0687-3921   | 2  |    | R: fxd comp 3900 ohms 10% 1/2w   | 01121 | EB3921         |
| R209         | 0758-0073   |    |    | R: fxd met ox 24k ohms 5% 1/2w   | hp    |                |
| R210         | 0687-3921   |    |    | R: fxd comp 3900 ohms 10% 1/2w   | 01121 | EB3921         |
| R211         | 0727-0201   | 1  |    | R: fxd depc 71.56k ohms 1% 1/2w  | hp    |                |
| R212         | 0687-1041   |    |    | R: fxd comp 100k ohms 10% 1/2w   | 01121 | EB1041         |
| R213         | 2100-0188   |    | 1  | R: var comp 200k ohms 20% 1/4w   | 11237 | VF-45          |
| R214         | 0686-1245   |    | 1  | R: fxd comp 120k ohms 5% 1/2w    | 01121 | EB1245         |
| R215         | 0686-2745   |    | 1  | R: fxd comp 270k ohms 5% 1/2w    | 01121 | EB2745         |
| R216         | 0727-0060   | 1  |    | R: fxd depc 225 ohms 1% 1/2w     | hp    |                |
| R221         | 0687-6831   | 3  |    | R: fxd comp 68k ohms 10% 1/2w    | 01121 | EB6831         |
| R222         | 0687-1011   |    |    | R: fxd comp 100 ohms 10% 1/2w    | 01121 | EB1011         |
| R223         | 0758-0073   |    |    | R: fxd met ox 24k ohms 5% 1/2w   | hp    |                |
| R224         | 0690-1041   |    |    | R: fxd comp 100k ohms 10% 1w     | 01121 | GB1041         |
| R225         | 0687-2731   |    | 4  | R: fxd comp 27k ohms 10% 1/2w    | 01121 | EB2731         |
| R226         | 0687-6841   | 2  |    | R: fxd comp 680k ohms 10% 1/2w   | 01121 | EB6841         |
| R227         | 0727-0110   | 1  |    | R: fxd depc 1500 ohms 1% 1/2w    | hp    |                |
| R228         | 0761-0076   | 1  |    | R: fxd met ox 18k ohms 5% 1w     | hp    |                |
| R229         | 0686-1055   | 1  |    | R: fxd comp 1 megohm 5% 1/2w     | 01121 | EB1055         |
| R230         | 0686-2055   |    |    | R: fxd comp 2 megohm 5% 1/2w     | 01121 | EB2055         |
| R241         | 0687-4711   | 1  |    | R: fxd comp 470 ohms 10% 1/2w    | 01121 | EB4711         |
| R242         | 0689-1835   |    |    | R: fxd comp 18k ohms 5% 1w       | 01121 | GB1835         |
| R243         | 0690-8231   |    | 1  | R: fxd comp 82k ohms 10% 1w      | 01121 | GB8231         |
| R244         | 0687-2731   |    |    | R: fxd comp 27k ohms 10% 1/2w    | 01121 | EB2731         |
| R245         | 0687-4711   |    |    | R: fxd comp 470 ohms 10% 1/2w    | 01121 | EB4711         |
| R246         | 0687-4741   | 1  |    | R: fxd comp 470k ohms 10% 1/2w   | 01121 | EB4741         |
| R247         | 2100-0094   | 2  |    | R: var comp 50k ohms 30% 0.1w    | 11237 | UPE 70 SPECIAL |
| R251         | 0771-0006   | 1  |    | R: fxd met ox 27k ohms 10% 4w    | hp    |                |
| R252         | 0687-1241   | 1  |    | R: fxd comp 120k ohms 10% 1/2w   | 01121 | EB1241         |
| R253         | 0687-1041   |    |    | R: fxd comp 100k ohms 10% 1/2w   | 01121 | EB1041         |
| R254         | 2100-0144   | 2  |    | R: var comp 250k ohms 30% 0.1w   | 11237 | UPE 70         |
| R255         | 0758-0006   | 1  |    | R: fxd met ox 10k ohms 5% 1/2w   | hp    |                |
| R256         | 0686-4345   | 1  |    | R: fxd comp 430k ohms 5% 1/2w    | 01121 | EB4345         |



Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Design | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)                            | Mfr   | Mfr Part No.   |
|---------------|-------------|----|----|--|-------|----------------|
| R257          | 0758-0073   | 1  |    | R: fxd met ox 24k ohms 5% 1/2w                             | hp    | OBD<br>EB2731  |
| R258          | 2100-0093   |    |    | R: var comp 20k ohms 20% 0.1w                              | 11237 |                |
| R259          | 0687-2731   |    |    | R: fxd comp 27k ohms 10% 1/2w                              | 01121 |                |
| R261          | 0687-1051   | 6  |    | R: fxd comp 1 megohm 10% 1/2w                              | 01121 | EB1051         |
| R262          | 0727-0376   | 1  |    | R: fxd depc 1.98 megohm 1% 1/2w                            | hp    |                |
| R263          | 0727-0173   | 1  |    | R: fxd depc 20k ohms 1% 1/2w                               | hp    |                |
| R264          | 0727-0285   | 1  |    | R: fxd depc 1.8 megohm 1% 1/2w                             | hp    |                |
| R265          | 0757-0128   | 1  |    | R: fxd met film 200k ohms 1% 1/2w                          | hp    |                |
| R266          | 0687-4731   | 1  |    | R: fxd comp 47k ohms 10% 1/2w                              | 01121 | EB4731         |
| R267          | 2100-0094   |    |    | R: var comp 50k ohms 30% 0.1w                              | 11237 | UPE 70 SPECIAL |
| R268          | 0727-0132   |    |    | R: fxd depc 4000 ohms 1% 1/2w                              | hp    |                |
| R269          | 0727-0100   | 1  |    | R: fxd depc 1000 ohms 1% 1/2w                              | hp    |                |
| R270          | 0687-6841   |    |    | R: fxd comp 680k ohms 10% 1/2w                             | 01121 | EB6841         |
| R271          | 0727-0292   | 4  |    | R: fxd depc 3 megohm 1% 1/2w                               | hp    |                |
| R272          | 0727-0292   |    |    | R: fxd depc 3 megohm 1% 1/2w                               | hp    |                |
| R273          | 0727-0292   |    |    | R: fxd depc 3 megohm 1% 1/2w                               | hp    |                |
| R274          | 0727-0292   | 1  |    | R: fxd depc 3 megohm 1% 1/2w                               | hp    |                |
| R275A/B       | 2100-0338   |    |    | R: var comp log dual 100k ohms 20% 1/4w<br>(includes S103) | 11237 | OBD            |
| R276          | 0687-3931   | 1  |    | R: fxd comp 39k ohms 10% 1/2w                              | 01121 | EB3931         |
| R277          | 0687-2231   | 1  |    | R: fxd comp 22k ohms 10% 1/2w                              | 01121 | EB2231         |
| R278          | 0687-2741   |    |    | R: fxd comp 270k ohms 10% 1/2w                             | 01121 | EB2731         |
| R279          | 0687-1541   |    |    | R: fxd comp 150k ohms 10% 1/2w                             | 01121 | EB1541         |
| R301          | 0687-1021   | 2  |    | R: fxd comp 1000 ohms 10% 1/2w                             | 01121 | EB1021         |
| R302          | 0687-1041   |    |    | R: fxd comp 100k ohms 10% 1/2w                             | 01121 | EB1041         |
| R303          | 0693-1541   |    |    | R: fxd comp 150k ohms 10% 2w                               | 01121 | HB1541         |
| R304          | 0690-5641   | 1  |    | R: fxd comp 560k ohms 10% 1w                               | 01121 | GB5641         |
| R305          | 0687-1051   |    |    | R: fxd comp 1 megohm 10% 1/2w                              | 01121 | EB1051         |
| R306          | 0687-1551   | 1  |    | R: fxd comp 1.5 megohm 10% 1/2w                            | 01121 | EB1551         |
| R307          | 0686-2455   | 1  |    | R: fxd comp 2.4 megohm 5% 1/2w                             | 01121 | EB2455         |
| R308          | 2100-0096   | 1  |    | R: var comp 1 megohm 30% 0.1w                              | 11237 | UPE 70 SPECIAL |
| R309          | 0693-5651   | 3  |    | R: fxd comp 5.6 megohm 10% 2w                              | 01121 | HB 5651        |
| R310          | 0693-5651   |    |    | R: fxd comp 5.6 megohm 10% 2w                              | 01121 | HB 5651        |
| R311          | 0693-5651   | 1  |    | R: fxd comp 5.6 megohm 10% 2w                              | 01121 | HB 5651        |
| R312          | 2100-0105   |    |    | R: var comp 3.5 megohm 30% 1/2w                            | 11237 | UPE 70         |
| R313          | 0687-5641   |    |    | R: fxd comp 560k ohms 10% 1/2w                             | 01121 | EB5641         |
| R314          | 0687-2731   | 1  |    | R: fxd comp 27k ohms 10% 1/2w                              | 01121 | EB2731         |
| R315          | 0687-6831   |    |    | R: fxd comp 68k ohms 10% 1/2w                              | 01121 | EB6831         |
| R316          | 2100-0095   | 1  |    | R: var comp 100k ohms 30% 0.1w                             | 11237 | OBD            |
| R317          | 0687-6831   | 1  |    | R: fxd comp 68k ohms 10% 1/2w                              | 01121 | EB6831         |
| R318          | 0687-2251   |    |    | R: fxd comp 2.2 megohm 10% 1/2w                            | 01121 | EB2251         |
| R319          | 0687-3331   |    |    | R: fxd comp 33k ohms 10% 1/2w                              | 01121 | EB3331         |
| R320          | 2100-0102   | 2  |    | R: var comp 500k ohms 30% 0.1w                             | 11237 | UPE 70 SPECIAL |
| R321          | 2100-0171   | 1  |    | R: var comp 200k ohms 20% 1/4w (includes S301)             | 11237 | VF-45          |
| R322          | 0687-1041   |    |    | R: fxd comp 100k ohms 10% 1/2w                             | 01121 | EB1041         |
| R323          | 0693-8251   |    |    | R: fxd comp 8.2 megohm 10% 2w                              | 01121 | HB8251         |
| R324          | 0693-8251   | 3  |    | R: fxd comp 8.2 megohm 10% 2w                              | 01121 | HB8251         |
| R325          | 0693-8251   |    |    | R: fxd comp 8.2 megohm 10% 2w                              | 01121 | HB8251         |

Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig                            | hp Part No.   | RS               | TQ | Description<br>(See Table 6-1. )   | Mfr                                       | Mfr Part No.                                   |
|---|---|------------------|----|--|---|--|
| R326<br>R327                            | 0687-4731<br>0687-2751  | 1                |    | R: fxd comp 47k ohms 10% 1/2w<br>R: fxd comp 2.7 megohm 10% 1/2w   | 01121<br>01121                            | EB4731<br>EB2751                               |
| R331<br>R332<br>R333<br>R334<br>R335    | 0687-1051<br>0687-1051<br>0690-1841<br>0690-4741<br>0687-1051 | 1<br>1<br>1      |    | R: fxd comp 1 megohm 10% 1/2w<br>R: fxd comp 1 megohm 10% 1/2w<br>R: fxd comp 180k ohms 10% 1w<br>R: fxd comp 470k ohms 10% 1w<br>R: fxd comp 1 megohm 10% 1/2w      | 01121<br>01121<br>01121<br>01121<br>01121 | EB1051<br>EB1051<br>GB1841<br>GB4741<br>EB1051 |
| R336<br>R337<br>R338<br>R339<br>R340    | 0687-4731<br>0687-4711<br>0687-1021<br>0727-0236<br>0727-0218 | 1<br>1<br>1      |    | R: fxd comp 47k ohms 10% 1/2w<br>R: fxd comp 470 ohms 10% 1/2w<br>R: fxd comp 1000 ohms 10% 1/2w<br>R: fxd depc 360k ohms 10% 1/2w<br>R: fxd depc 180k ohms 1% 1/2w  | 01121<br>01121<br>01121<br>hp<br>hp       | EB4731<br>EB4711<br>EB1021                     |
| R341<br>R342                            | 0727-0378<br>0687-4711  | 1                |    | R: fxd depc 257.1k ohms 1% 1/2w<br>R: fxd comp 470 ohms 10% 1/2w   | hp<br>01121                               | EB4711   |
| R351<br>R352<br>R353<br>R354<br>R355    | 0727-0287<br>2100-0144<br>0727-0289<br>0687-8241<br>0687-8231 | 1<br>1<br>1<br>1 |    | R: fxd depc 2 megohm 1% 1/2w<br>R: var comp 250k ohms 30% 0.1w<br>R: fxd depc 2.52 megohm 1% 1/2w<br>R: fxd comp 820k ohms 10% 1/2w<br>R: fxd comp 82k ohms 10% 1/2w | hp<br>11237<br>hp<br>01121<br>01121       | UPE 70<br>EB8241<br>EB8231                     |
| R356<br>R357<br>R358<br>R359            | 0761-0006<br>0687-1831<br>0687-1531<br>0687-1051              | 1<br>1           |    | R: fxd met ox 10k ohms 5% 1w<br>R: fxd comp 18k ohms 10% 1/2w<br>R: fxd comp 15k ohms 10% 1/2w<br>R: fxd comp 1 megohm 10% 1/2w                                      | hp<br>01121<br>01121<br>01121             | EB1831<br>EB1531<br>EB1051                     |
| R361<br>R362<br>R363<br>R364A/B<br>R365 | 0699-0006<br>0699-0006<br>0767-0010<br>2100-0150<br>0687-3331 | 2<br>1<br>1      |    | R: fxd comp 4.7 ohms 10% 1w<br>R: fxd comp 4.7 ohms 10% 1w<br>R: fxd met ox 15k ohms 5% 3w<br>R: var comp dual 10k ohms 20% 1/4w<br>R: fxd comp 33k ohms 10% 1/2w    | 01121<br>01121<br>hp<br>11237<br>01121    | GB47G1<br>GB47G1<br>UPE 70<br>EB3331           |
| S1<br>S2<br>S3A/B/C                     | 3101-0011<br>3101-0010  | 3<br>1           |    | S: slide dpdt (p/o A3)<br>NSR: part of A2<br>S: pushbutton dpdt  | 82389<br>82389                            | 11A-1013<br>3S-1407                            |
| S101<br>S102<br>S103                    | 3101-0011<br>3101-0011  |                  |    | S: slide dpdt (p/o A102)<br>S: slide dpdt (p/o A101)<br>NSR: part of R275A/B   | 82389<br>82389                            | 11A-1013<br>11A-1013                           |
| S201<br>S202<br>S204                    |   |                  |    | NSR: part of A201<br>NSR: part of R213<br>NSR: part of A204  |   |  |
| S301                                    |   |                  |    | NSR: part of R321  |   |  |
| T301<br>T302                            | 120A-11A-1<br>9100-0156                                       | 1<br>1           |    | T: high voltage<br>T: power  | hp<br>98734                               | 6-1691   |

Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1. )     | Mfr   | Mfr Part No.              |
|--------------|-------------|----|----|--------------------------------------|-------|---------------------------|
| V1           | 1932-0029   | 5  |    | V: electron dual triode 12AU7        | hp    | A092                      |
| V2           | 1932-0029   |    |    | V: electron dual triode 12AU7        | hp    |                           |
| V3           | 1932-0035   | 3  |    | V: electron dual triode 6DJ8         | hp    |                           |
| V4           | 2140-0084   |    |    | V: glow lamp aged                    | 74276 |                           |
| V5           | 2140-0084   | 6  |    | V: glow lamp aged                    | 74276 |                           |
| V101         | 1932-0029   |    |    | V: electron dual triode 12AU7        | hp    |                           |
| V102         | 1932-0035   |    |    | V: electron dual triode 6DJ8         | hp    |                           |
| V201         | 1932-0035   | 3  |    | V: electron dual triode 6DJ8         | hp    |                           |
| V202         | 1933-0014   |    |    | V: electron triode - pentode 6GH8A   | hp    |                           |
| V203         | 1932-0029   | 1  |    | V: electron dual triode 12AU7        | hp    |                           |
| V204         | 1921-0005   |    |    | V: electron triode 6C4               | hp    |                           |
| V205         | 1933-0014   |    |    | V: electron triode - pentode 6GH8A   | hp    |                           |
| V206         | 2140-0084   |    |    | V: glow lamp aged                    | 74276 | A092                      |
| V207         | 2140-0084   |    |    | V: glow lamp aged                    | 74276 | A092                      |
| V208         | 2140-0084   |    |    | V: glow lamp aged                    | 74276 | A092                      |
| V209         | 2140-0084   |    |    | V: glow lamp aged                    | 74276 | A092                      |
| V301         | 1932-0029   | 1  |    | V: electron dual triode 12AU7        | hp    |                           |
| V302         | 1923-0018   |    |    | V: electron beam power pentode 6AQ5  | hp    |                           |
| V303         | 1920-0001   | 2  |    | V: electron high voltage diode 5642  | hp    |                           |
| V304         | 1920-0001   |    |    | V: electron high voltage diode 5642  | hp    |                           |
| V305         | 5083-0353   | 1  |    | CRT: P31 phosphor internal graticule | hp    |                           |
| V307         | 1921-0010   | 2  |    | V: electron low-mu triode 12B4A      | hp    |                           |
| V308         | 1933-0014   |    |    | V: electron triode - pentode 6GH8A   | hp    |                           |
| V309         | 1921-0010   | 1  |    | V: electron low-mu triode 12B4A      | hp    |                           |
| V310         | 1923-0021   |    |    | V: electron pentode 6AU6             | hp    |                           |
| V311         | 1940-0001   | 1  |    | V: electron voltage reference 5651A  | hp    |                           |
| W1           | 8120-0050   | 1  |    | W: power cord (includes P301)        | 70903 | CS-9941/PH-151/<br>7.5 ft |
| XV1          | 1200-0062   | 12 |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV2          | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV3          | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV101        | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV102        | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV201        | 1200-0062   | 4  |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV202        | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV203        | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |
| XV204        | 1200-0053   |    |    | XV: 7 pin minat                      | 71785 | 111-51-11-069             |
| XV205        | 1200-0062   |    |    | XV: 9 pin minat                      | 71785 | 121-51-11-060             |



Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig  | hp Part No. | RS | TQ | Description<br>(See Table 6-1.)                 | Mfr   | Mfr Part No.  |
|---|-------------|----|----|---|-------|---------------|
| XV301   | 1200-0062   |    |    | XV: 9 pin minat                                 | 71785 | 121-51-11-060 |
| XV302   | 1200-0053   |    |    | XV: 7 pin minat                                 | 71785 | 111-51-11-069 |
| XV305   |             |    |    | NSR - consists of:                              |       |               |
|   | 1200-0037   |    |    | Socket: crt                                     | hp    |               |
|   | 1200-0050   |    |    | Pin: crt socket                                 | hp    |               |
|   | 1200-0192   |    |    | Cover: crt socket                               | hp    |               |
| XV307   | 1200-0062   |    |    | XV: 9 pin minat                                 | 71785 | 121-51-11-060 |
| XV308   | 1200-0062   |    |    | XV: 9 pin minat                                 | 71785 | 121-51-11-060 |
| XV309   | 1200-0062   |    |    | XV: 9 pin minat                                 | 71785 | 121-51-11-060 |
| XV310   | 1200-0053   |    |    | XV: 7 pin minat                                 | 71785 | 111-51-11-069 |
| XV311   | 1200-0053   |    |    | XV: 7 pin minat                                 | 71785 | 111-51-11-069 |
| XQ301   | 1200-0041   | 1  |    | XQ: 2 pin                                       | 71785 | 133-92-10-034 |
| <b>MISCELLANEOUS</b>  |             |    |    |   |       |               |
|   | 0370-0026   | 2  |    | Knob: 3/4 inch black w/arrow                    | hp    |               |
|   | 0370-0037   | 2  |    | Knob: 1 inch skirted black w/arrow              | hp    |               |
|   | 0370-0062   | 2  |    | Knob: 3/4 inch red w/arrow                      | hp    |               |
|   | 0370-0084   | 2  |    | Knob: 5/8 inch black w/arrow                    | hp    |               |
|   | 0370-0113   | 1  |    | Knob: 3/4 inch skirted black w/arrow            | hp    |               |
|   | 0370-0114   | 1  |    | Knob: 5/8 inch red w/arrow                      | hp    |               |
|   | 0905-0016   | 1  |    | Gasket: felt (crt)                              | hp    |               |
|   | 1200-0043   | 1  |    | Insulator: anodized alum (for Q301)             | 76530 | 293011        |
|   | 1205-0003   | 1  |    | Insulator: transistor (Q301)                    | hp    |               |
|   | 1205-0007   | 1  |    | Dissipator: heat (nut)                          | hp    |               |
|   | 1205-0008   | 1  |    | Dissipator: heat (body)                         | hp    |               |
|   | 5000-0408   | 3  |    | Bracket: coil alignment                         | hp    |               |
|   | 5040-0401   | 7  |    | Support: hv capacitor                           | hp    |               |
|   | 5040-0421   | 1  |    | Insulator: hv (intensity pot)                   | hp    |               |
|   | 5040-0466   | 1  |    | Retainer: crt shield                            | hp    |               |
|   | 120A-20A    | 1  |    | Bezel: crt                                      | hp    |               |
|   | 120B-1A     | 1  |    | Deck: main                                      | hp    |               |
|   | 120B-1B     | 1  |    | Deck: capacitor                                 | hp    |               |
|   | 120B-5A     | 1  |    | Bracket: angle center                           | hp    |               |
|   | 120B-6D     | 1  |    | Shield: sync                                    | hp    |               |
|   | 120B-16B    | 1  |    | Cable: vertical input                           | hp    |               |
|   | 120B-6F     | 1  |    | Assy: crt shield                                | hp    |               |
|   | 120B-16F    | 1  |    | Cable: main harness                             | hp    |               |
|   | 120B-83D    | 1  |    | Support: pc board stiffener                     | hp    |               |
| <b>SPECIAL ORDER CRT'S</b>                                      |             |    |    |   |       |               |
|   | 5083-0323   |    |    | CRT: P2 phosphor internal graticule             | hp    |               |
|   | 5083-0333   |    |    | CRT: P7 pyosphor internal graticule             | hp    |               |
|   | 5083-0342   |    |    | CRT: P11 phosphor aluminized internal graticule | hp    |               |
| <b>OPTION 05</b>  |             |    |    |   |       |               |
| (Parts required in addition to, or instead of, standard parts.) |             |    |    |   |       |               |
|   | 0693-4711   | 1  |    | R: fxd comp 470 ohms 10% 2w                     | hp    |               |
|   | 1370-0084   | 1  |    | Knob: 5/8 inch black w/arrow                    | hp    |               |
|   | 1450-0084   | 4  |    | Lampholder: screw base miniature                | hp    |               |
|   | 2100-1838   | 1  |    | R: var comp 300 ohms 20% 1w, with spst switch   | hp    |               |
|   | 2140-0057   | 4  |    | Lamp: 6 v incd miniature screw base             | 24455 | 1768          |

Table 6-2. Replaceable Parts (Cont'd)

| Ref<br>Desig | hp Part No. | RS | TQ | Description<br>(See Table 6-1. )                                | Mfr   | Mfr Part No.        |
|--------------|-------------|----|----|---|-------|---------------------|
|              |             |    |    | <b>OPTION 05 (cont'd)</b>                                       |       |                     |
|              | 5040-0420   |    | 1  | Mask: light   | hp    |                     |
|              | 5083-0310   |    |    | CRT: P1 phosphor w/o internal graticule                         | hp    |                     |
|              | 5083-0320   |    |    | CRT: P2 phosphor w/o internal graticule                         | hp    |                     |
|              | 5083-0330   |    |    | CRT: P7 phosphor w/o internal graticule                         | hp    |                     |
|              | 5083-0340   |    |    | CRT: P11 phosphor w/o internal graticule                        | hp    |                     |
|              | 5083-0350   |    | 1  | CRT: P31 phosphor w/o internal graticule                        | hp    |                     |
|              | 9100-1108   |    | 1  | T: power  | hp    |                     |
|              | 120A-83A    |    |    | Filter: light amber (for P7 phosphor)                           | hp    |                     |
|              | 120A-83B    |    |    | Filter: light blue (for P31 phosphor)                           | hp    |                     |
|              | 120A-83C    |    |    | Graticule: external scribed                                     | hp    |                     |
|              | 120A-83G    |    | 1  | Filter: light green (for P1, P2, P31 phosphor)                  | hp    |                     |
|              | 120B-2F     |    | 1  | Panel: front  | hp    |                     |
|              | 120B-83C-1  |    |    | Graticule: external unscribed                                   | hp    |                     |
|              | 120B-83E    |    | 1  | Retainer: crt   | hp    |                     |
|              |             |    |    | <b>OPTION 06</b>  |       |                     |
|              |             |    |    | (Parts required in addition to, or instead of, standard parts.) |       |                     |
|              | 2151-0038   |    | 2  | Connector: 3 pin female   | 71468 | CA3106A10SL-3S-A105 |
|              | 2151-0040   |    | 2  | Clamp: cable  | 71468 | AN3057-4            |
|              | 120B-2G     |    | 1  | Panel: rear   | hp    |                     |
|              | 120B-16J    |    | 1  | Cable: 20 inch  | hp    |                     |
|              | 120B-16K    |    | 1  | Cable: 26 inch  | hp    |                     |
|              |             |    |    | <b>OPTION 13</b>  |       |                     |
|              |             |    |    | (Parts required in addition to, or instead of, standard parts.) |       |                     |
|              | 120B-2H     |    | 1  | Panel: front  | hp    |                     |
|              | 120B-5B     |    | 2  | Casting: frame side   | hp    |                     |
|              | 120B-6G     |    | 1  | Assy: vertical shield (A101)                                    | hp    |                     |
|              | 120B-12P    |    | 2  | Assy: ac/dc switch (A3, A102)                                   | hp    |                     |
|              | 120B-37A    |    | 2  | Bar: panel mounting   | hp    |                     |
|              | 120B-47A    |    | 2  | Support: panel  | hp    |                     |

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H-1 (Name to Code) and H-4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H-4 handbooks.

| Code No. | Manufacturer                                    | Address                  | Code No. | Manufacturer  | Address                           | Code No. | Manufacturer                                     | Address                     |
|----------|---|--------------------------|----------|---|-----------------------------------|----------|--|-----------------------------|
| 00000    | U. S. A. Common                                 | Any supplier of U. S.    | 01726    | Digitalon Co.   | Pasadena, Calif.                  | 14774    | Tranex Company                                   | Mountain View, Calif.       |
| 00136    | McCoy Electronics                               | Mount Holly Springs, Pa. | 01737    | Transistor Electronics Corp.                                  | Minneapolis, Minn.                | 18042    | Power Design Pacific Inc.                        | Palo Alto, Calif.           |
| 00131    | Sage Electronics Corp.                          | Rochester, N. Y.         | 01738    | Westinghouse Electric Corp.                                   | Elmira, N. Y.                     | 18476    | Y-Car Mfg. Co., Inc.                             | Holliston, Mass.            |
| 00287    | Cenco Inc.                                      | Danielson, Conn.         | 01749    | Electronic Tube Div.  | New York, N. Y.                   | 18486    | Radio Industries                                 | Des Plaines, Ill.           |
| 00334    | Humidrol  | Cotton, Calif.           | 01753    | Filmhite Corp.  | New York, N. Y.                   | 18583    | Curis Instrument, Inc.                           | Wilmette, N. Y.             |
| 00373    | Galtek Inc.,                                    |                          | 01753    | Cinch-Graph Co.   | City of Industry, Calif.          | 18873    | E. I. DuPont & Co., Inc.                         | Wilmington, Del.            |
|          | Electronics Products Div.                       | Candem, N. J.            | 01761    | Avnet Corp.   | Los Angeles, Calif.               | 18911    | Durant Mfg. Co.                                  | Milwaukee, Wis.             |
| 00556    | Aerovox Corp.                                   | New Bedford, Mass.       | 01763    | Fairchild Camera & Inst. Corp.                                | Mountain View, Calif.             | 19315    | Bendix Corp., The                                | Teterboro, N. J.            |
| 00779    | Amp, Inc.                                       | Harrisburg, Pa.          | 01763    | Minneapolis Rubber Co.  | Minneapolis, Minn.                | 19300    | Thomas A. Edison Industries, Div.                | West Orange, N. J.          |
| 00781    | Aircraft Radio Corp.                            | Bonnton, N. J.           | 01782    | Birtcher Corp., The   | Monterey Park, Calif.             | 19644    | McGraw-Edison Co.                                | Horsesheds, N. Y.           |
| 00815    | Northern Engineering Laboratories, Inc.         | Burlington, W. C.        | 01787    | Technical Wire Products Inc.                                  | Cranford, N. J.                   | 20183    | General Atomics Corp.                            | Philadelphia, Pa.           |
| 00853    | Sangamo Electric Co.,                           | Pickens, S. C.           | 01790    | Continental Device Corp.                                      | Hawthorne, Calif.                 | 21226    | Eucetone, Inc.                                   | New York, N. Y.             |
|          |   |                          | 01793    | Raytheon Mfg. Co.,  | Mountain View, Calif.             | 21335    | Falco Bearing Co., The                           | New Britain, Conn.          |
| 00856    | Goe Engineering Co.                             | Los Angeles, Calif.      | 01796    | Shockley Semi-Conductor Laboratories                          | Palo Alto, Calif.                 | 21455    | Fansett Metallurgical Corp.                      | N. Chicago, Ill.            |
| 00861    | Carl E. Holmes Corp.                            | Los Angeles, Calif.      | 01798    | Hewlett-Packard Co.,  | Boonton Radio Div.                | 24635    | General Radio Co.                                | West Concord, Mass.         |
| 01121    | Allen Bradley Co.                               | Milwaukee, Wis.          | 01849    | U. S. Engineering Co.   | Los Angeles, Calif.               | 24655    | Gies Reproduction Corp.                          | New Rochelle, N. Y.         |
| 01255    | Liton Industries, Inc.                          | Beverly Hills, Calif.    | 01849    | Blinn, Delbert Co.  | Pomona, Calif.                    | 24662    | Goblet File Co. of America, Inc.                 | Carlstadt, N. J.            |
| 01281    | TW Semiconductors, Inc.                         | Lawrence, Calif.         | 01854    | Burgess Battery Co.   | Niagara Falls, Ontario, Canada    | 26492    | Hamilton Watch Co.                               | La Grange, Pa.              |
| 01295    | Texas Instruments, Inc.                         | Dallas, Texas            | 01856    | Bristol Co., The  | Waterbury, Conn.                  | 26480    | Hewlett-Packard Co.                              | Palo Alto, Calif.           |
|          | Transistor Products Div.                        |                          | 01877    | Sloan Company   | San Valley, Calif.                | 33173    | G. E. Receiving Tube Dept.                       | Owensboro, Ky.              |
| 01349    | The Alliance Mfg. Co.                           | Van Nuys, Calif.         | 01878    | ITT Cannon Electric Inc.,                                     | Phoenix, Arizona                  | 34443    | Leitch Inc.                                      | Chicago, Ill.               |
| 01389    | Pacific Relay, Inc.                             | Rockford, Ill.           | 01892    | CBS Electronics Corp.   | Operations, Div. of C. B. S. Inc. | 35196    | Stanwix Coil Products Ltd.                       | Hawkesbury, Ontario, Canada |
| 01930    | Aerocor Corp.                                   | Santa Clara, Calif.      |          |   |                                   | 37942    | P. R. Malloy & Co. Inc.                          | Indianapolis, Ind.          |
| 01961    | Pulse Engineering Co.                           | Santa Clara, Calif.      | 01984    | Mel-Rain  | Indianapolis, Ind.                | 39543    | Mechanical Industries Prod. Co.                  | Akron, Ohio                 |
| 02114    | Ferrotec Corp. of America                       | Saugerties, N. Y.        | 01986    | Babcock Relays Div.   | Costa Mesa, Calif.                | 40920    | Miniature Precision Bearings, Inc.               | Keene, N. H.                |
| 02286    | Cole Rubber and Plastics Inc.                   | Smyrna, Calif.           | 01945    | Texas Capacitor Co.   | Houston, Texas                    | 42190    | Meter Co.  | Chicago, Ill.               |
| 02680    | Amphenol-Borg Electronics Corp.                 | Chicago, Ill.            | 01948    | Alpha Electronics   | San Valley, Calif.                | 42960    | G. A. Noigen Co.                                 | Englewood, Colo.            |
| 02735    | Radio Corp. of America, Semiconductor           | Somerville, N. J.        | 01950    | Electro Assemblies, Inc.                                      | Chicago, Ill.                     | 44555    | Ohmif Mfg. Co.                                   | Skokie, Ill.                |
|          | Materials Div.                                  |                          | 01959    | Mallory Battery Co. of  | Canada, Ltd.                      | 47904    | Poland Corp.                                     | Cambridge, Mass.            |
| 02771    | Vocaline Co. of America, Inc.                   | Old Saybrook, Conn.      | 02014    | General Transistor Western Corp.                              | Los Angeles, Calif.               | 48620    | Precision Thermometer & Inst. Co.                | Southampton, Pa.            |
|          |   |                          | 10411    | TI-Tal, Inc.  | Berkeley, Calif.                  | 49556    | Microwave & Power Tube Div.                      | Westminster, Md.            |
| 02777    | Hopkins Engineering Co.                         | San Fernando, Calif.     | 10426    | Carburonum Co.  | Niagara Falls, N. Y.              | 52993    | Santorum Company                                 | Walpole, Mass.              |
| 03508    | G. E. Semiconductor Prod. Dept.                 | Syracuse, N. Y.          | 11236    | City of Borne, Inc.   | Berne, Ind.                       | 54294    | Shallcross Mfg. Co.                              | Selma, N. C.                |
| 03705    | Apex Machine & Tool Co.                         | Dayton, Ohio             | 11237    | Chicago Telephone of California, Inc.                         | So. Pasadena, Calif.              | 55026    | Sensopac Electronics Corp.                       | Chicago, Ill.               |
| 03797    | Eldem Co.                                       | Compton, Calif.          | 11242    | Bay State Electronics Corp.                                   | Walpole, Mass.                    | 55593    | Sentone Corp.                                    | Elmsford, N. Y.             |
| 03877    | Transitron Electric Corp.                       | Wakelield, Mass.         | 11312    | Microwave Electronics Corp.                                   | Palo Alto, Calif.                 | 55938    | Raytheon Co. Commercial Apparatus & Systems Div. | So. Norwalk, Conn.          |
| 03888    | Pysseval Resistor Co., Inc.                     | Cedar Knolls, N. J.      | 11534    | Duncan Electronics Inc.                                       | Costa Mesa, Calif.                | 56137    | Spaulding Fine Co., Inc.                         | Tonawanda, N. Y.            |
| 03944    | Singer Co., Diehl Div.                          | Flanders Plant           | 11571    | General Instrument Corp., Semiconductor                       | Newark, N. J.                     | 56289    | Sprague Electric Co.                             | North Adams, Mass.          |
| 04009    | Aron, Hart and Hegeman Elect. Co.               | Hartford, Conn.          |          |   |                                   | 59446    | Telex, Inc.                                      | St. Paul, Minn.             |
|          |   |                          | 11717    | Imperial Electronic, Inc.                                     | Buena Park, Calif.                | 59700    | Thomas & Betts Co.                               | Elizabeth, N. J.            |
| 04013    | Taurus Corp.                                    | Lansherville, N. Y.      | 11870    | Metals, Inc.  | Palo Alto, Calif.                 | 60174    | Triplet Electrical Inst. Co.                     | Bluffton, Ohio              |
| 04062    | Elenco Products Co.                             | New York, N. Y.          | 12156    | Philadelphia Handle Co.                                       | Candem, N. J.                     | 60791    | Union Switch and Signal, Div. of                 | Pittsburgh, Pa.             |
| 04222    | Hi-Q Division of Aerovox                        | Myrtle Beach, S. C.      | 12242    | Bay State Electronics Corp.                                   | Walpole, Mass.                    | 62119    | Universal Electric Co.                           | Powassa, Mich.              |
| 04354    | Precision Paper Tube Co.                        | Chicago, Ill.            | 11312    | Microwave Electronics Corp.                                   | Palo Alto, Calif.                 | 63743    | Ward-Leonard Electric Co.                        | St. Vernon, N. Y.           |
| 04404    | Dynac Division of Hewlett-Packard Co.           | Palo Alto, Calif.        | 11534    | Duncan Electronics Inc.                                       | Costa Mesa, Calif.                | 64559    | Western Electric Co., Inc.                       | New York, N. Y.             |
| 04651    | Sylvania Electric Products, Microwave           | Mountain View, Calif.    | 11717    | Imperial Electronic, Inc.                                     | Buena Park, Calif.                | 65092    | Weston Inst. Inc. Weston-Newark                  | Newark, N. J.               |
|          | Device Div.                                     |                          | 11870    | Metals, Inc.  | Palo Alto, Calif.                 | 66225    | Wiltek Mfg. Co.                                  | Chicago, Ill.               |
| 04713    | Motrola, Inc., Semiconductor Prod. Div.         | Phoenix, Arizona         | 12156    | Philadelphia Handle Co.                                       | Candem, N. J.                     | 66236    | Reverse Hollands Div. Minn. Mining & Mtl. Co.    | St. Paul, Minn.             |
| 04732    | Filtron Co., Inc. Western Div.                  | Culver City, Calif.      | 12242    | Bay State Electronics Corp.                                   | Walpole, Mass.                    | 70245    | Atlantic India Rubber Works, Inc.                | Chicago, Ill.               |
|          |   |                          | 12859    | Nippon Electric Co., Ltd.                                     | Tokyo, Japan                      | 70563    | Amperite Co., Inc.                               | Union City, N. J.           |
| 04773    | Automatic Electric Co.                          | Northlake, Ill.          | 12881    | Melen Electronics Corp.                                       | Cian, N. J.                       | 70983    | Belden Mfg. Co.                                  | Chicago, Ill.               |
| 04796    | Sesqua Wire Co.                                 | Redwood City, Calif.     | 12930    | Metel Electronics Corp.                                       | Newport Beach, Calif.             | 70989    | Bird Electronic Corp.                            | Cleveland, Ohio             |
| 04811    | Precision Coil Spring Co.                       | El Monte, Calif.         | 12953    | Dickson Electronics Corp.                                     | Scottsdale, Arizona               | 71012    | Binnbach Relectric Co.                           | New York, N. Y.             |
| 04870    | P. M. Motor Company                             | Westchester, Ill.        | 13103    | Thermolloy  | Dallas, Texas                     | 71284    | Boston Gear Works Div. of Murray Co. of Texas    | Quincy, Mass.               |
| 05006    | Twentieth Century Plastics, Inc.                | Los Angeles, Calif.      | 13356    | Telelunks (GmbH)  | Hanover, Germany                  | 71286    | Bud Radio, Inc.                                  | Willoughby, Ohio            |
|          |   |                          | 13359    | Midland-Wright Div. of Pacific Industries, Inc.               | Kansas City, Kansas               | 71313    | Canlec Fastener Corp.                            | Paramus, N. Y.              |
| 05277    | Westinghouse Electric Corp. Sem-Conductor Dept. | Youngwood, Pa.           | 14099    | Sem-Tech  | Santa Monica, Calif.              | 71721    | Cardwell Condenser Corp.                         | Lindenhurst L. I., N. Y.    |
| 05347    | Ultronic, Inc.                                  | San Mateo, Calif.        | 14193    | Calif. Resistor Corp.   | San Jose, Calif.                  | 71400    | Bussmann Mfg. Div. of McGraw-Edison Co.          | St. Louis, Mo.              |
| 05593    | Humimetric Engineering Co.                      | Sunnyvale, Calif.        | 14798    | American Components, Inc.                                     | Cosmohocken, Pa.                  | 71436    | Chicago Condenser Corp.                          | Chicago, Ill.               |
| 05616    | Cosmo Plastic                                   | Cleveland, Ohio          | 14433    | ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp. | Loveland, Colo.                   | 71447    | Calif. Spring Co., Inc.                          | Pico-Rivera, Calif.         |
| 05624    | Barber Colman Co.                               | Rockford, Ill.           | 14453    | Hewlett-Packard Company                                       | Newark, N. J.                     | 71450    | CTS Corp.  | Elkhart, Ind.               |
| 05728    | Tiffen Optical Co.                              | Long Island, N. Y.       | 14653    | Connel Doubler Electric Corp.                                 | Newark, N. J.                     | 71461    | ITT Cannon Electric Inc.                         | Los Angeles, Calif.         |
| 05729    | Metro-Tel Corp.                                 | Westbury, N. Y.          | 14674    | Connell Glass Works   | Corning, N. Y.                    | 71477    | Cinema Plant, Hi-Q Div Aerovox                   | Aerovox                     |
| 05783    | Stewart Engineering Co.                         | Santa Cruz, Calif.       | 14752    | Electric Cube Inc.  | So. Pasadena, Calif.              | 71482    | C. P. Clare & Co.                                | Burbank, Calif.             |
| 05820    | Wakelield Engineering Inc.                      | Wakelield, Mass.         | 14960    | Williams Mfg. Co.   | San Jose, Calif.                  | 71490    | Central Div. of Globe Union Inc.                 | Chicago, Ill.               |
| 06004    | Dassick Co., The                                | Biddeford, Conn.         | 15203    | Webster Electronics Co.                                       | New York, N. Y.                   | 71636    | Commercial Plastics Co.                          | Milwaukee, Wis.             |
| 06175    | Bausch and Lomb Optical Co.                     | Rochester, N. Y.         | 15291    | Adjustable Bushing Co.  | N. Hollywood, Calif.              | 71700    | Cornish Wire Co., The                            | New York, N. Y.             |
| 06402    | E. T. A. Products Co. of America                | Chicago, Ill.            | 15558    | Micro Electronics   | Garden City, Long Island, N. Y.   |          |  |                             |
| 06475    | Western Devices Inc.                            | Burbank, Calif.          | 15772    | Twentieth Century Coil Spring Co.                             | Santa Clara, Calif.               |          |  |                             |
| 06540    | Aerand Electronic Hardware Co.                  | New Rochelle, N. Y.      | 15818    | Amelec Inc.   | MI. View, Calif.                  |          |  |                             |
| 06555    | Beede Electrical Instrument Co., Inc.           | Penacook, N. H.          | 15909    | Oven Div. Thomas A. Edison Inc.                               | Long Island City, N. Y.           |          |  |                             |
| 06566    | General Devices Co., Inc.                       | Indianapolis, Ind.       | 16037    | Spring Fine Mica Co.  | Spruce Pine, N. C.                |          |  |                             |
| 06751    | Nuclecor Corp. of America                       | Phoenix, Arizona         | 16175    | Omni-Spectra Inc.   | Detroit, Ill.                     |          |  |                             |
| 06812    | Torrington Mfg. Co., West Div.                  | Van Nuys, Calif.         | 16582    | Computer Data Corp.   | Lodi, N. J.                       |          |  |                             |
|          |   |                          | 16598    | Ideal Print. Meter Co., Inc.                                  | Brooklyn, N. Y.                   |          |  |                             |
| 06990    | Eitel-McCullough Inc.                           | San Carlos, Calif.       | 16758    | Delta Radio Div. of G. M. Corp.                               | Kokomo, Ind.                      |          |  |                             |
| 07008    | Kelvin Electric Co.                             | San Carlos, Calif.       | 17189    | Thermionics Inc.  | Canoga Park, Calif.               |          |  |                             |

From FSC Handbook Supplements  
H-4-1 Dated JULY 1955  
H-4-2 Dated NOV 1952



Table 6-3. Code List of Manufacturers (Cont'd)

| Code  | Manufacturer   | Address               | Code  | Manufacturer  | Address                | Code  | Manufacturer  | Address              | Code  | Manufacturer   | Address                |
|-------|--|-----------------------|-------|---|------------------------|-------|---|----------------------|---|--|------------------------|
| 81349 | Military Specification   | .....                 | 85474 | R.M. Biscamonte & Co.                                 | San Francisco, Calif.  | 93929 | G. V. Controls  | Livingston, N. J.    | 98220   | Francis L. Mosley  | Pasadena, Calif.       |
| 81415 | Wilbur Products, Inc.  | Cleveland, Ohio       | 85660 | Kent-Aids, Inc.                                       | New Haven, Conn.       | 93983 | Insuline-Van Norman Ind., Inc.                        | .....                | 98278   | Microdot, Inc.   | So. Pasadena, Calif.   |
| 81453 | .....  | .....                 | 85911 | Seamless Rubber Co.                                   | Chicago, Ill.          | ..... | Electronic Division                                   | Manchester, N. H.    | 98291   | Sealecric Corp.  | Manassas, N.Y.         |
| 81483 | Div. Industr. Tube Operations  | Newton, Mass.         | 86197 | Clifton Precision Products                            | Clifton Heights, Pa.   | 94137 | General Cable Corp.                                   | Bayonne, N. J.       | 98405   | Casad Corp.  | Redwood City, Calif.   |
| 81541 | International Rectifier Corp.  | El Segundo, Calif.    | 86519 | Precision Rubber Products Corp.                       | Dayton, Ohio           | 94144 | Raytheon Mfg. Co., Industrial Components              | .....                | 98731   | General Mills  | Minneapolis, Minn.     |
| 81860 | The Arpaex Products Co.  | Cambridge, Mass.      | 86584 | Radio Corp. of America, RCA                           | .....                  | ..... | Div. Receiving Tube Operation                         | Quincy, Mass.        | 98821   | North Hills Electric Co.                                 | Minneapolis, N.Y.      |
| 82042 | Barry Controls, Inc.   | Watertown, Mass.      | 87216 | Phico Corporation (Lansdale Division)                 | Harrison, N. J.        | 94145 | Raytheon Mfg. Co., Semiconductor Div.                 | .....                | 98925   | Clevite Transistor Prod.                                 | Waltham, Mass.         |
| 82042 | Carlier Patts Co.  | Spokane, Ill.         | 87473 | Western Fibrous Glass Products Co.                    | Lansdale, Pa.          | 94148 | Scientific Radio Products, Inc.                       | .....                | 98978   | Div. of Clevite Corp.                                    | .....                  |
| 82147 | Jeffers Electronics Division of Spier Carbon Co.                           | Du Bois, Pa.          | 87664 | Van Waters & Rogers, Inc.                             | San Francisco, Calif.  | 94154 | Tung-Sol Electric, Inc.                               | .....                | 99109   | International Electronic Research Corp.                  | Burbank, Calif.        |
| 82310 | Allen-B. Oulmet Labs, Inc.   | Clifton, N. J.        | 87930 | Tower Mfg. Corp.                                      | Seattle, Wash.         | 94197 | Curtiss-Wright Corp.                                  | .....                | 99313   | Varian Associates  | Palo Alto, Calif.      |
| 82229 | Maguire Industries, Inc.   | Greenwich, Conn.      | 88140 | Culter-Hammer, Inc.                                   | Providence, R. I.      | ..... | Electronics Div.                                      | East Paterson, N. J. | 99515   | Marshall Industries, Electron Products Division          | .....                  |
| 82219 | Sylvania Electric Prod. Inc.   | .....                 | 88400 | Culter-Hammer, Inc.                                   | Lincoln, Ill.          | 94222 | Southco Div. of S. Chester Corp.                      | .....                | 99707   | Control Switch Division, Controls Co.                    | Pasadena, Calif.       |
| 82376 | Aston Co.  | East Newark, N. J.    | 88220 | Gold/National Batteries, Inc.                         | St. Paul, Minn.        | 94310 | Trio Ohm Prod. Div. of Model Engineering and Mfg. Co. | Chicago, Ill.        | 99800   | Delevan Electronics Corp.                                | El Segundo, Calif.     |
| 82789 | Switchcraft, Inc.  | Chicago, Ill.         | 88698 | General Mills, Inc.                                   | Buffalo, N. Y.         | 94320 | Wire Cloth Products Inc.                              | Chicago, Ill.        | 99848   | Wilco Corporation  | Indianapolis, Ind.     |
| 82647 | Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods. | Attleboro, Mass.      | 89231 | Graybar Electric Co.                                  | Oakland, Calif.        | 94682 | Worcester Pressed Aluminum Corp.                      | .....                | 99834   | Rehband, Inc.  | Boston, Mass.          |
| 82666 | Research Products Corp.  | Madison, Wis.         | 89462 | Waides Kohinor, Inc.                                  | Cambridge, Mass.       | ..... | Philbrick Researchers, Inc.                           | Worcester, Mass.     | 99842   | Hoffman Servoconductor Div. of Hoffman Electronics Corp. | Evanston, Ill.         |
| 82877 | Rotom-Manufacturing Co., Inc.  | Woodstock, N. J.      | 89473 | General Electric Distributing Corp.                   | Schenectady, N. Y.     | 95073 | Philbrick Researchers, Inc.                           | Boston, Mass.        | 99957   | Technology Instrument Corp. of Calif.                    | Newbury Park, Calif.   |
| 82893 | Vector Electronic Co.  | Glendale, Calif.      | 89636 | Carter Parts Div. of Economy Baler Co.                | Chicago, Ill.          | 95236 | Alvies Products Corp.                                 | Miami, Fla.          | THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK. |  |                        |
| 82958 | Western Washer Mfg. Co.  | Los Angeles, Calif.   | 89665 | United Transformer Co.                                | Chicago, Ill.          | 95238 | Continental Connector Corp.                           | Woodside, N. Y.      |   |  |                        |
| 83058 | Carr Fastener Corp.  | Cambridge, Mass.      | 90179 | U. S. Rubber Co., Mechanical Goods Div.               | Passaic, N. J.         | 95263 | Leecraft Mfg. Co., Inc.                               | New York, N. Y.      |   |  |                        |
| 83086 | New Hampshire Ball Bearing, Inc.   | Peterborough, N. H.   | 90970 | Bearing Engineering Co.                               | San Francisco, Calif.  | 95264 | Leecraft Mfg. Co., Inc.                               | Burbank, Calif.      |   |  |                        |
| 83125 | Pyramid Electric Co.   | Darlington, S. C.     | 91260 | Connor Spring Mfg. Co.                                | San Francisco, Calif.  | 95265 | National Coil Co.                                     | Sheridan, Wyo.       | 0000F   | Malco Tool and Die                                       | Santa Monica, Calif.   |
| 83148 | Electro Cords Co.  | Los Angeles, Calif.   | 91345 | Miller Dial & Nameplate Co.                           | El Monte, Calif.       | 95275 | Vitamon, Inc.   | Bridgeport, Conn.    | 0000G   | Western Coil Div. of Automatic Ind., Inc.                | Los Angeles, Calif.    |
| 83186 | Victory Engineering Corp.  | Springfield, N. J.    | 91418 | Radio Materials Co.                                   | Chicago, Ill.          | 95348 | Gidasco, Inc.   | Bloomfield, N. J.    | 0000P   | Ty-Cal Mfg. Co., Inc.                                    | Redwood City, Calif.   |
| 83298 | Bendix Corp., Red Bank Div.  | Red Bank, N. J.       | 91506 | Angat Brothers, Inc.                                  | Attleboro, Mass.       | 95354 | Method Mfg. Co.                                       | Chicago, Ill.        | 0000Z   | Willow Leather Products Corp.                            | Hawthorn, N. J.        |
| 83315 | Hubbell Corp.  | Mundelein, Ill.       | 91637 | Dale Electronics, Inc.                                | Columbus, Nebr.        | 95372 | Oape Electric Co., Inc.                               | Franklin, Ind.       | 0000A   | British Radio Electronics Ltd.                           | Washington, D. C.      |
| 83330 | Smith, Herman H., Inc.   | Brooklyn, N. Y.       | 91662 | Elco Corp.  | Philadelphia, Pa.      | 95387 | Weckesser Co.   | Chicago, Ill.        | 0000B   | ETA  | England                |
| 83385 | Central Screw Co.  | Chicago, Ill.         | 91737 | Gremat Mfg. Co., Inc.                                 | Waukegan, Mass.        | 96067 | Higgins Laboratories                                  | Sunnyvale, Calif.    | 0000C   | Indiana General Corp., Elect. Div.                       | Indianapolis, Ind.     |
| 83501 | Gavitt Wire and Cable Co., Div. of Amrace Corp.                            | Brookfield, Mass.     | 91827 | K. P. Development Co.                                 | Redwood City, Calif.   | 96095 | Hi-Q Division of Aerovox                              | Olean, N. Y.         | 0000D   | Precision Instrument Components Co.                      | Van Nuys, Calif.       |
| 83594 | Burroughs Corp., Electronic Tube Div.                                      | Plainfield, N. J.     | 91929 | Minneapolis-Honeywell Regulator Co., Microswitch Div. | Freeport, Ill.         | 96256 | Thordarson-Messner Div. of Maguire Industries, Inc.   | Los Angeles, Calif.  | 0000E   | Rubber Eng. & Development                                | Hayward, Calif.        |
| 83740 | Evereard Battery   | New York, N. Y.       | 91961 | Nahn-Bros. Spring Co.                                 | Oakland, Calif.        | 96290 | Solar Manufacturing Co.                               | Chicago, Ill.        | 0000N   | A "N" D Manufacturing Co.                                | San Jose 27, Calif.    |
| 83777 | Model Eng. and Mfg., Inc.  | Huntington, Ind.      | 92186 | Trio-Connector Corp.                                  | Peabody, Mass.         | 96341 | Microwave Associates, Inc.                            | Burlington, Mass.    | 0000Q   | Coltronic  | Oakland, Calif.        |
| 83821 | Lloyd Struggs Co.  | Festus, Mo.           | 92367 | Universal Metal Prod., Inc.                           | Bassett Pointe, Calif. | 96501 | Excel Transformer Co.                                 | Oakland, Calif.      | 0000S   | Control of Elgin Watch Co.                               | Burlington, Calif.     |
| 83926 | Arco Electronics, Inc.   | New York, N. Y.       | 92607 | Elgeet Optical Co., Inc.                              | Rochester, N. Y.       | 97444 | Industrial Retaining Ring Co.                         | Livingston, N. J.    | 0000W   | California Eastern Lab.                                  | Burlington, Calif.     |
| 84171 | A. J. Gieseler Co., Inc.   | San Francisco, Calif. | 92607 | Tinsolite Insulated Wire Co.                          | Tarrytown, N. Y.       | 97539 | Automatic and Precision Mfg. Co.                      | Yonkers, N. Y.       | 0000Y   | S. K. Smith Co.  | Los Angeles 45, Calif. |
| 84396 | A. J. Gieseler Co., Inc.   | San Francisco, Calif. | 93332 | Sylvania Electric Prod. Inc., Semiconductor Div.      | Woburn, Mass.          | 97966 | CBS Electronics, Div. of C. B. S., Inc.               | Danvers, Mass.       | From FSC Handbook Supplements<br>H4-1 Dated DECEMBER 1964<br>H4-2 Dated MARCH 1962  |  |                        |
| 84411 | Good All Electric Mfg. Co.   | Ogallala, Neb.        | 93369 | Rabbin and Myers, Inc.                                | New York, N. Y.        | 97979 | Rear Resistor Corp.                                   | Yonkers, N. Y.       |   |  |                        |
| 84970 | Sarkis Tazian, Inc.  | Bloomington, Ind.     | 93410 | Stevens Mfg. Co., Inc.                                | Mansfield, Ohio        | 98141 | Axel Brothers Inc.                                    | Jamaica, N. Y.       |   |  |                        |
| 85454 | Boston Molding Company   | Boston, N. J.         | 93788 | Howard J. Smith Inc.                                  | Port Monmouth, N. J.   | 98159 | Raytheon Mfg. Co., Industrial Components              | Gardena, Calif.      |   |  |                        |
| 85471 | A. B. Boyd Co.   | San Francisco, Calif. | 93788 | Howard J. Smith Inc.                                  | Port Monmouth, N. J.   | 98159 | Raytheon Mfg. Co., Industrial Components              | .....                |   |  |                        |
| 98159 | Raytheon Mfg. Co., Industrial Components                                   | .....                 | 98159 | Raytheon Mfg. Co., Industrial Components              | .....                  | 98159 | Raytheon Mfg. Co., Industrial Components              | .....                |   |  |                        |
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| 98159 | Raytheon Mfg. Co., Industrial Components                                   | .....                 | 98159 | Raytheon Mfg. Co., Industrial Components              | .....                  |       |   |                      |   |  |                        |

## APPENDIX I MANUAL CHANGES

This appendix contains information on changes required to adapt this manual to an instrument with a serial prefix listed in the table below. Check for your instrument serial prefix and make the changes indicated. Note that these changes adapt the manual to cover a particular instrument as manufactured and therefore will not apply to an instrument subsequently modified in the field. Refer to Section I for information on errata in this manual and on any other instrument serial prefix not covered in this appendix.

| Instrument<br>Serial Prefix | Make Numbered<br>Changes |
|-----------------------------|--------------------------|
| 502-                        | 1                        |
| 433-                        | 1, 2                     |
| 421-                        | 1, 2, 3                  |
| 327-, 403-, 409-            | 1, 2, 3, 4               |
| 303-                        | 1, 2, 3, 4, 5            |
| 242-, 247-                  | 1, 3, 4, 5, 6            |
| 202-, 217-, 219-, 223-      | 1, 3, 4, 5, 6, 7         |

### CHANGE 1

Page 5-16, Figure 5-7,

R108, R110: Change value to 330K.

Tables 6-1 and 6-2,

R108, R110: Change to hp Part No. 0687-3341;  
R: fxd, comp, 330K ohms, 10%, 1/2W; Mfr  
01121; Mfr Part No. EB3341.

### CHANGE 2

Tables 6-1 and 6-2,

C322A/B: Change to hp Part No. 0180-0127; C:  
fxd, elect 2-sect, 120 x 40  $\mu$ f, -10% +50%  
300VDCW; Mfr 56289; Mfr Part No. D36235.

### CHANGE 3

Tables 6-1 and 6-2,

A1: Change to hp Part No. 120B-65A.

A202: Change to hp Part No. 120B-65B.

CR305: Change to hp Part No. 1902-0759; Mfr  
04713; Mfr Part No. 1N2983B.

### CHANGE 4

Page 5-17, Figure 5-8,

R207: Change value to 18K ohms.

Page 5-18, Figure 5-9,

R351: Change value to 1.88M ohms.

Tables 6-1 and 6-2,

R207: Change to hp Part No. 0687-1031; R: fxd,  
comp, 10K ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB1031.

R351: Change to hp Part No. 0727-0286; R: fxd,  
depc, 1.88M ohms, 1% 1/2W; Mfr hp.

### CHANGE 5

Tables 6-1 and 6-2,

CR201: Change to hp Part No. 1901-0034; Diode:  
Si; Mfr 07933; Mfr Part No. DW204A.

### CHANGE 6

Tables 6-1 and 6-2,

A201: Change to hp Part No. 120B-19C.

C321: Change to hp Part No. 0180-0042; C: fxd,  
elect, 120  $\mu$ f, 350VDCW; Mfr 56289; Mfr Part  
No. D3253.

C325A/B: Change to hp Part No. 0180-0030; C: fxd,  
elect, 2-sect, 120 x 40  $\mu$ f, 450VDCW; Mfr 56289;  
Mfr Part No. D32352.

MISCELLANEOUS,

Knob: TRIGGER SOURCE selector: Change to  
hp Part No. 0370-0099.

Knob: TRIGGER LEVEL control: Change to hp  
Part No. 0370-0134.

### CHANGE 7

Page 5-19, Figure 5-10,

C305, C307: Change value to 6800 pf.

C308: Relocate into A302 in parallel with T301  
pin 5 and plate of V303, and change value to  
1500 pf.

C310: Relocate into A302 in parallel with T301  
pin 9 and plate of V304, and change value to  
1500 pf.

C312: Change value to .015  $\mu$ f.

C313, C314: Delete.

R313: Change value to 680K ohms.

R322: Change value to 47K ohms.

R327: Change value to 1.5M ohms.

Tables 6-1 and 6-2,

A301: Change to hp Part No. 120B-65C.

A302: Change to hp Part No. 120B-11A.

C305, C307: Change to hp Part No. 0160-0110;  
C: fxd, paper, 6800 pf, 20% 3000VDCW; Mfr  
56289; Mfr Part No. 184P152050.

C308, C310: Change to hp Part No. 0160-0061; C:  
fxd, paper, 1500 pf, 20% 500VDCW; Mfr 56289;  
Mfr Part No. 184P152050.

C312: Change to hp Part No. 0160-0062; C: fxd,  
paper, .015  $\mu$ f, 10% 3000VDCW; Mfr 56289;  
Mfr Part No. 184P153930.

C313, C314: Delete.

CR304: Change to hp Part No. 1901-0026; Diode:  
Si; Mfr hp.

R313: Change to hp Part No. 0687-6841; R: fxd,  
comp, 680K ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB6841.

R322: Change to hp Part No. 0687-4731; R: fxd,  
comp, 47K ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB4731.

R327: Change to hp Part No. 0687-1551; R: fxd,  
comp, 1.5M ohms, 10% 1/2W; Mfr 01121; Mfr  
Part No. EB1551.







## CATHODE-RAY TUBE WARRANTY

The cathode-ray tube (CRT) supplied in your Hewlett-Packard Oscilloscope and replacement CRT's purchased from hp are warranted by the Hewlett-Packard Company against electrical failure for a period of one year from the date of sale. Broken tubes and tubes with phosphor or mesh burns are not included under this warranty. If the CRT is broken when received, a claim should be made with the responsible carrier.

Your nearest Hewlett-Packard Sales/Service Office (listed at rear of instrument manual) maintains a stock of replacement tubes and will assist in processing the warranty claim.

We would like to evaluate every defective CRT. This engineering evaluation helps us to provide a better product for you. Please fill out the CRT Failure Report on the reverse side of this sheet and return it with the defective CRT to:

Hewlett-Packard Company  
1900 Garden of the Gods Road  
Colorado Springs, Colorado 80907

Attention: CRT QA

To avoid damage to the tube while in shipment, please follow the shipping instructions below; warranty credit is not allowed on broken tubes.

### SHIPPING INSTRUCTIONS

It is preferable that the defective CRT be returned in the replacement CRT carton. If the carton or packaging material is not available, pack the CRT according to the instructions below:

1. Carefully wrap the tube in 1/4 inch thick cotton batting or other soft padding material.
2. Wrap the above in heavy kraft paper.
3. Pack wrapped tube in a rigid container which is at least 4 inches larger than the tube in each dimension.
4. Surround the tube with at least 4 inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.

Thank you,

CRT Department



## CRT WARRANTY CLAIM

FROM: \_\_\_\_\_ Date \_\_\_\_\_

NAME \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

For additional information, contact:

NAME \_\_\_\_\_

TITLE \_\_\_\_\_

COMPANY \_\_\_\_\_

ADDRESS \_\_\_\_\_

1.  INSTRUMENT a) MODEL \_\_\_\_\_

b) SERIAL NO. \_\_\_\_\_

2. CRT a) TYPE (on bulb) \_\_\_\_\_

b) SERIAL NO. (on CRT base) \_\_\_\_\_

3. Is defective tube original. YES \_\_\_\_\_ NO \_\_\_\_\_

4. Date purchased (if available) \_\_\_\_\_

5. Describe nature and/or symptoms of trouble. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

6. Describe operating conditions prior to and at time of failure.  
(Please estimate CRT "on-time" since purchase.)

\_\_\_\_\_

\_\_\_\_\_

CUT ALONG DOTTED LINE





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2003 Byrd Spring Road S.W.  
Huntsville 35802  
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TWX: 810-726-2204

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Scottsdale 85251  
Tel: (602) 945-7601  
TWX: 910-950-1282

5737 East Broadway  
Tucson 85716  
Tel: (602) 298-2313  
TWX: 910-952-1162

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1430 East Orangethorpe Ave.  
Fullerton 92631  
Tel: (714) 870-1000

3939 Lankershim Boulevard  
North Hollywood 91604  
Tel: (213) 877-1282  
TWX: 910-499-2170

1101 Embarras Road  
Palo Alto 94303  
Tel: (415) 327-6500  
TWX: 910-373-1280

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Sacramento 95821  
Tel: (916) 482-1463  
TWX: 910-367-2092

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San Diego 92106  
Tel: (714) 223-8103  
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TWX: 710-468-3750

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Herndon Station 32814  
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TWX: 810-850-0113

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St. Petersburg  
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TWX: 810-863-0366

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Rockville 20850  
Tel: (301) 948-6370  
TWX: 710-828-9684

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TWX: 710-990-4951

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Tel: (609) 667-4000  
TWX: 710-892-4945

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TWX: 910-989-1665

156 Wyatt Drive  
Las Cruces 88001  
Tel: (505) 526-2485  
TWX: 910-983-0550

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Tel: (807) 754-0050  
TWX: 510-252-0890

82 Washington Street  
Poughkeepsie 12601  
Tel: (914) 454-7330  
TWX: 510-248-0012

39 Saginaw Drive  
Rochester 14623  
Tel: (716) 473-9500  
TWX: 510-253-5981

1025 Northern Boulevard  
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King of Prussia 19406  
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4242 Richmond Avenue  
Houston 77027  
Tel: (713) 567-2407  
TWX: 910-881-2645

### GOVERNMENT CONTRACT OFFICE

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San Antonio 78226  
Tel: (512) 434-4171  
TWX: 910-871-1170

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TWX: 910-925-5681

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Ltda.  
Apartado Aereo 6287  
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Cable: AARIS Bogota

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Lic. Alfredo Gallegos Gurdian  
Apartado 3243  
San Jose  
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Cable: GALTUR San Jose

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Post Office Box 3199  
Quito  
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27 Avenida Norte 1133  
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Tel: SATRON 3450 332

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Cable: LABORINSTRUMENT  
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Telex: 60048 HEWPACK ORsay  
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Lietzenburgerstrasse 30  
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Barcelona 6  
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Ataio Ingenieros  
Enrique Larreta 12  
Madrid, 16  
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Hagakergatan 9C  
431 04 Mölndal 4  
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Hewlett-Packard (Sverige) AB  
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S171 20 Solna 1  
Tel: (08) 98 12 50  
Cable: MEASUREMENTS  
Stockholm  
Telex: 10721

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Zürich  
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Cable: HEWPACKAG Zurich  
Telex: 53933

Hewlett Packard (Schweiz) A.G.  
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1217 Meyrin-Geneva  
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Cable: HEWPACKSA Geneva  
Telex: 2 24 86

**TURKEY**  
Telekom Engineering Bureau  
P.O. Box 376 - Galata  
Istanbul  
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Cable: TELEMATION Istanbul

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Telex: 21790

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Cable: TELETRA Luanda

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Telex: 31024

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Cable: HEWPARD Sydney

Hewlett-Packard Australia  
Pty. Ltd.  
97 Churchill Road  
Prospect 5082  
South Australia  
Tel: 65.2366  
Cable: HEWPARD Adelaide

Hewlett Packard Australia  
Pty. Ltd.  
2nd Floor, Suite 13  
Casablanca Buildings  
196 Adelaide Terrace  
Perth, W.A. 6000

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Colombo 2  
Tel: 5496  
Cable: HOTPOINT Colombo

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Nicosia  
Tel: 6282-75628  
Cable: HE-I-NAMI

**ETHIOPIA**  
African Salespower & Agency  
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Addis Ababa  
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Cable: ASACO Addisababa

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Hong Kong  
Tel: 240168, 232735  
Cable: SCHMIDTCO Hong Kong

**INDIA**  
The Scientific Instrument  
Co., Ltd.  
6, Tej Bahadur Sapru Road  
Allahabad 1  
Tel: 2451  
Cable: SICO Allahabad

The Scientific Instrument  
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